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Vehicle Technologies Heavy Vehicle Program: FY 2008 Benefits Analysis, Methodology and Results—Final Report

Energy Systems Division

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Vehicle Technologies Heavy Vehicle Program: FY 2008 Benefits Analysis, Methodology and Results— Final Report

for
U.S. Department of Energy
Energy Efficiency and Renewable Energy
Office of Planning, Budget, & Analysis

by
TA Engineering, Inc.
Technical Analysis and Engineering
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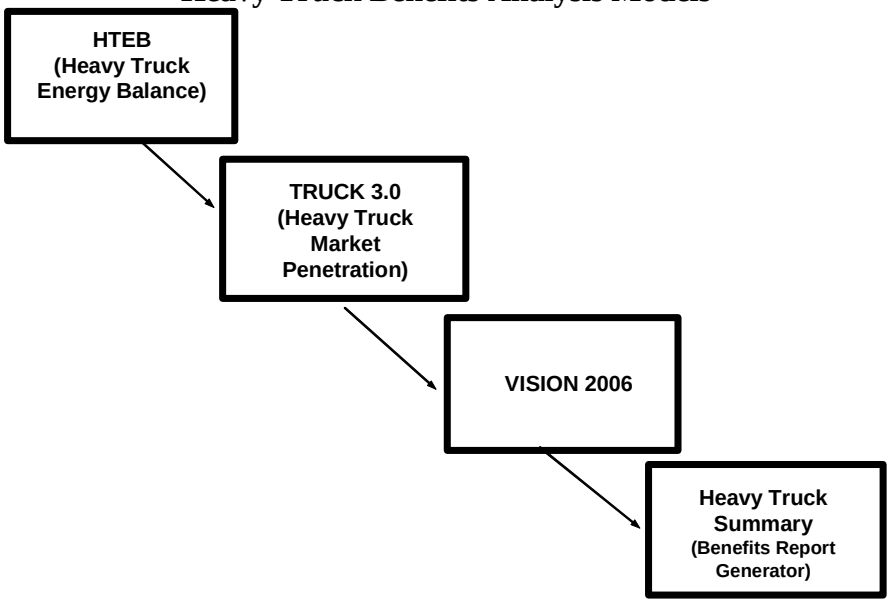
Executive Summary

An analysis of the petroleum and carbon reduction benefits associated with Heavy Vehicle technologies supported by the Vehicle Technologies Program has been completed for the FY 2008 Budget request. The analysis utilizes a series of spreadsheet models to characterize the fuel economy of various vehicle configurations, estimate market penetration, calculate energy and emissions effects to 2050, and generate reports explaining the benefits and how they relate to the various truck market sectors.

Exhibit ES-1:
Heavy Truck Benefits Analysis Models



The four models used to complete the analysis and their relationships are indicated in Exhibit ES-1. As the exhibit shows, the models are used sequentially beginning with the Heavy Truck Energy Balance model. This tool enables the systematic analysis of energy conservation techniques that affect the engine as well as other elements of the vehicle system.

The Heavy Vehicle market characteristics used in the analysis disaggregates Class 7 and 8 vehicles based on similarities in duty cycle. In addition, the benefits analysis addresses Class 3 through 6 Medium Trucks. Key characteristics of the market segmentation are indicated in Exhibit ES-2. Truck configurations are briefly described on the "Body Types" row. Classes 3 thru 6 vehicles are disaggregated according to whether they use gasoline or diesel fuel. The market segmentation indicated in Exhibit ES-2

Exhibit ES-2: Heavy Vehicle Characteristics (2002)

Vehicle Type	Class 7 & 8	Class 7 & 8	Class 3 through 6 Diesel	Class 3 through 6 Gasoline	Comments
Body Types	Combination Units	Single Units	--	--	
Fuel Economy (Baseline)	6.10	6.70	8.90	9.40	
Fuel Economy Improvement, %	155%	150%	145%	144%	Combined effect of FCVT Technologies, 2020-2050
Average Miles Traveled, miles	96,300	13,000	23,100	11,800	
Portion of Heavy Truck Fuel Use, %	72%	13%	11%	4%	Estimated--Year 2005
Portion of Vehicle Travel < 50 k Miles, %	5%	68%	84%	98%	
Portion of Vehicle Travel 50 k to 100 k Miles, %	26%	25%	12%	2%	
Portion of Vehicle Travel >100 k Miles, %	69%	7%	4%	0%	

is new for the FY 2008 analysis. Vehicle characteristics are based on the 2002 Vehicle Inventory and use (VIUS) survey data.

The principal inputs required to conduct the analysis are: changes in fuel economy—expressed as 'multipliers' compared to the baseline vehicles, and the incremental cost of the technology. Factors used for the FY 2008 analysis are summarized in Exhibit ES-3.

Exhibit ES-3: Fuel Economy Improvement and Cost Assumptions

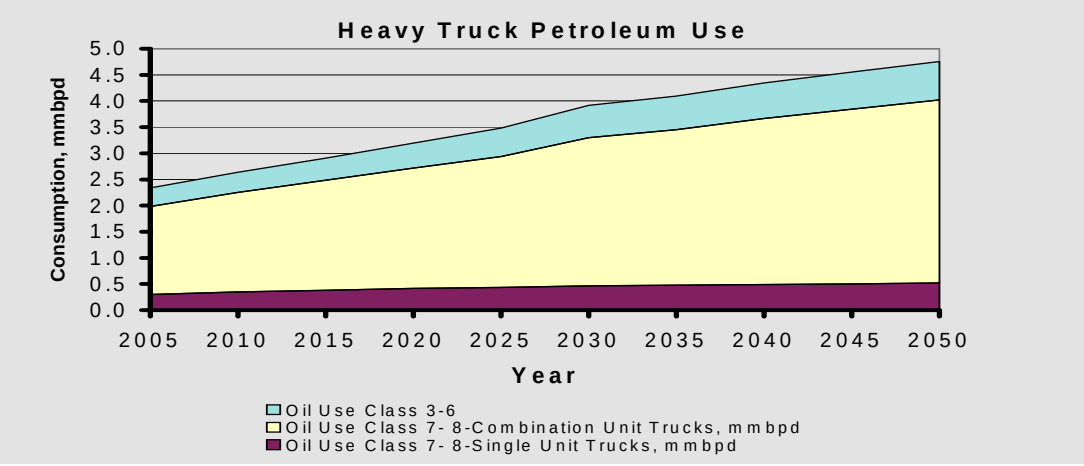
	Characteristic	2010	2020	2030	2040	2050
1	Fuel Economy Class 7-8, Combination Unit mpg Multiplier	1.29	1.55	1.55	1.55	1.55
2	Fuel Economy Class 7-8, Single Unit mpg Multiplier	1.28	1.50	1.50	1.50	1.50
3	Fuel Economy Class 3-6 Gasoline, mpg Multiplier	1.24	1.45	1.45	1.45	1.45
4	Fuel Economy Class 3-6-Diesel, mpg Multiplier	1.24	1.44	1.44	1.44	1.44
5	Class 7-8, Iincremental Cost, $	$ 30,000	$ 15,000	$ 10,000	$ 10,000	$ 10,000
6	Class 3-6 Gasoline, Incremental Cost, $	$ 5,000	$ 2,000	$ 1,500	$ 1,500	$ 1,500
7	Class 3-6 Diesel, Incremental Cost, $	$ 7,500	$ 2,500	$ 2,000	$ 2,000	$ 2,000

Incremental costs are high initially, but are assumed to reduce as the rise in the market penetration occurs. "Out year" costs are indicative of a 2-year payback on the investment. As a result, the costs rows on Exhibit ES-3 should be viewed as "cost goals."

Total current and estimated future petroleum use by Heavy Vehicles is quantified as part of the analysis. Estimated Heavy and Medium Truck use to 2050 is indicated in Exhibit ES-4.

Exhibit- ES-4: Heavy Vehicle Petroleum Use before VT Program Benefits (MBPD)

Characteristic	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
Oil Use Class 7-8-Combination Unit Trucks, mmbpd	1.682	1.908	2.104	2.303	2.502	2.833	2.974	3.174	3.339	3.498
Oil Use Class 7-8-Single Unit Trucks, mmbpd	0.299	0.348	0.381	0.417	0.439	0.466	0.474	0.489	0.503	0.518
Oil Use Class 3-6	0.357	0.380	0.423	0.477	0.543	0.615	0.648	0.679	0.706	0.736
Total:	2.339	2.636	2.908	3.196	3.483	3.914	4.096	4.342	4.548	4.752

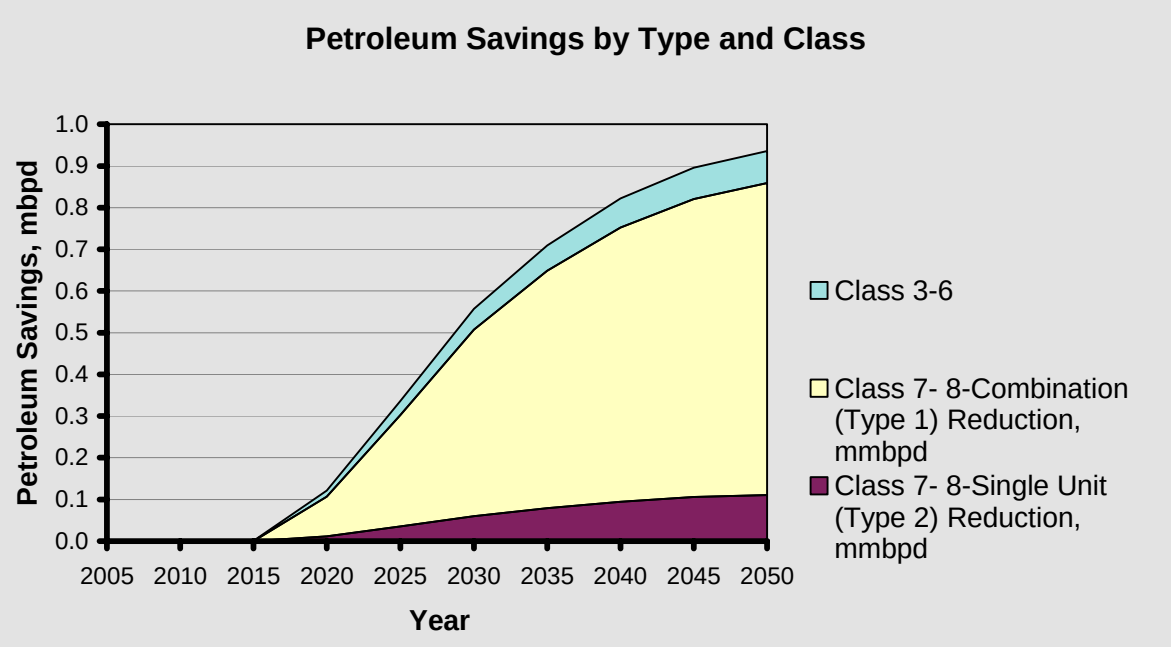


From the graph it is apparent that Heavy Vehicle energy currently is dominated by the combination unit (cab and separate trailer) trucks, and that this will continue throughout the analysis period. The information in Exhibit ES-4 indicates expected consumption absent the effects of the DOE program.

Petroleum reductions expected due to the VT program were analyzed from several perspectives. Exhibit ES-5 illustrates expected savings to 2050 by market segment.

Exhibit ES-5:
Petroleum Savings due to VT Technologies by Market Segment (MBPD)

Market Segment	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
Class 7- 8-Combination (Type 1) Reduction, mmbpd	0.00	0.00	0.00	0.09	0.27	0.45	0.57	0.66	0.72	0.75
Class 7- 8-Single Unit (Type 2) Reduction, mmbpd	0.00	0.00	0.00	0.01	0.03	0.06	0.08	0.09	0.11	0.11
Class 3-6	0.00	0.00	0.00	0.02	0.03	0.05	0.06	0.07	0.08	0.08
Totals:	**0.00**	**0.00**	**0.00**	**0.12**	**0.34**	**0.56**	**0.71**	**0.82**	**0.90**	**0.94**



Not surprisingly, most of the savings occur in the Class 7 and 8 Combination Unit segment. The market segment with next highest level of savings is from Single Unit (cab and trailer on a single chassis) (Class 7 and 8). Relative to single units, the savings in that sector are slightly greater than in the Class 3-6 (Medium Truck) market.

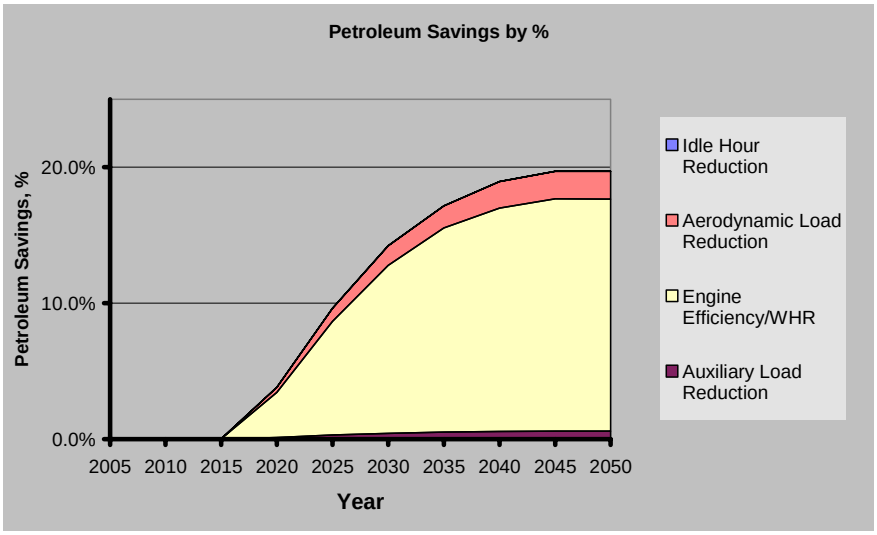
Benefits also were evaluated in relation to the characteristics of the technology (or technical opportunity) considered. Benefits by technology will be affected by both the estimated efficiency benefit and the vehicle use characteristics of the market segment.

Exhibit ES-6 presents petroleum savings as a percent of total baseline petroleum use for all Heavy Vehicles. Engine efficiency (with Waste Heat Reduction and Parasitic Load Reduction) is estimated to have a per-vehicle benefit of up to thirty eight percent, and is the principal contributor to the overall savings. The exhibit indicates that the potential exists to reduce Heavy Vehicle petroleum use by twenty percent by 2050.

Note that due to funding limitations, vehicle weight reduction and hybrid technologies are not included in the VT heavy vehicle program portfolio, a change from the previous year's program portfolio.

Exhibit ES-6:
Petroleum Reduction due to Vehicle Technologies as a Percentage of Base Consumption

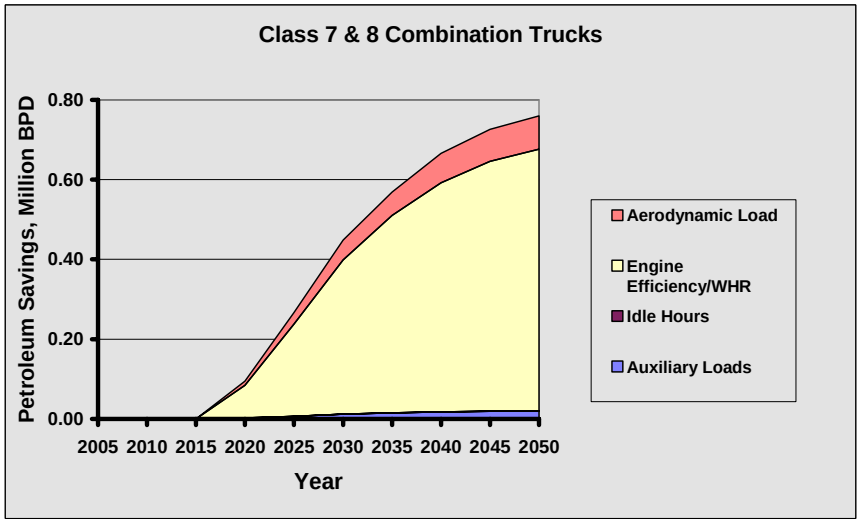
Technology	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
Auxiliary Load Reduction	0.0%	0.0%	0.0%	0.1%	0.3%	0.4%	0.5%	0.6%	0.6%	0.6%
Idle Hour Reduction	0.0000%	0.0001%	0.0003%	0.0005%	0.0006%	0.0007%	0.0007%	0.0006%	0.0006%	0.0006%
Engine Efficiency/WHR	0.0%	0.0%	0.0%	3.3%	8.4%	12.4%	15.0%	16.4%	17.1%	17.1%
Aerodynamic Load Reduction	0%	0.0%	0.0%	0.4%	1.0%	1.5%	1.6%	1.9%	2.0%	2.0%
Totals:	**0%**	**0%**	**0%**	**4%**	**10%**	**14%**	**17%**	**19%**	**20%**	**20%**



The effects of the VT technologies were also analyzed to estimate petroleum savings potential by market segment. Exhibit ES-7 summarizes the potential in the Class 7 & 8 Combination Unit.

Exhibit ES-7: Benefits in Class 7 & 8 Combination Unit Segment of Vehicle Technologies (MBPB)

Technology	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
Auxiliary Loads	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.02	0.02	0.02
Idle Hours	0.00000	0.00000	0.00001	0.00001	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002
Engine Efficiency/WHR	0.00	0.00	0.00	0.08	0.23	0.39	0.50	0.57	0.63	0.66
Aerodynamic Load	0.00	0.00	0.00	0.01	0.03	0.05	0.06	0.07	0.08	0.08
Total, Type 1	**0.00**	**0.00**	**0.00**	**0.10**	**0.27**	**0.45**	**0.57**	**0.67**	**0.73**	**0.76**

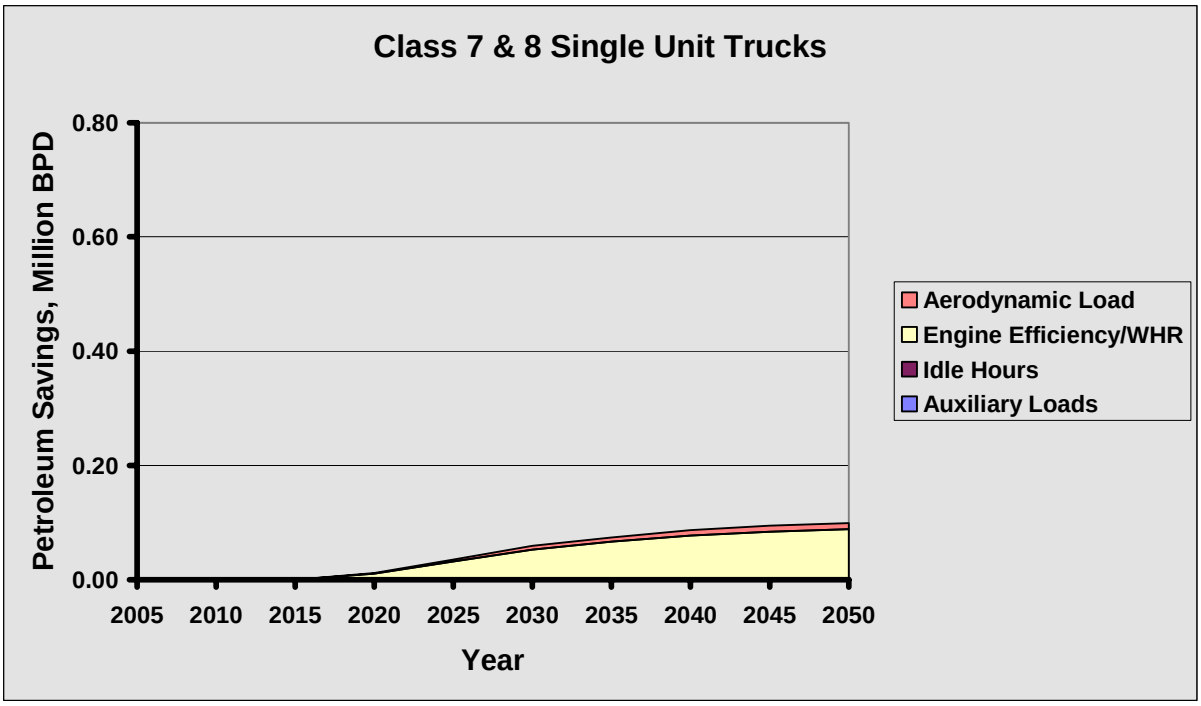


For the combination unit segment in a given year, engine efficiency represents more than eighty percent of the savings opportunity. Aerodynamic reduction by electrification is the next most significant contributing technology, but represents about ten percent of the expected savings. The other technologies combined represent less than ten percent of the savings.

Petroleum savings expectations relative to the Single Unit Use Heavy Truck Market Segment are summarized in ES-8:

Exhibit ES-8: Benefits in Single Unit Segment of Vehicle Technologies (MBPD)

Msrket Segment	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
Auxiliary Loads	0.000	0.000	0.000	0.000	0.001	0.002	0.002	0.002	0.002	0.003
Idle Hours	0.000000	0.000000	0.000001	0.000002	0.000003	0.000003	0.000003	0.000003	0.000003	0.000003
Engine Efficiency/WHR	0.000	0.000	0.000	0.010	0.031	0.051	0.065	0.075	0.082	0.086
Aerodynamic Load	0.000	0.000	0.000	0.001	0.004	0.006	0.008	0.010	0.010	0.011
Total, Type 2	**0.00**	**0.00**	**0.00**	**0.01**	**0.04**	**0.06**	**0.07**	**0.09**	**0.09**	**0.10**



This segment is expected to account for less than twenty percent of the savings that will occur in the Long Haul segment. The relative contributions by technology are similar to the patterns for the Medium trucks.

Exhibit ES-9 is a tabular summary of the program benefits analysis results for the years 2010, 2020, 2030, 2040, and 2050. Information contained in the table includes the following:

- Rows 1-8: Total oil use before conservation by Market Segment
- Rows 9-16: Total Savings by Market Segment
- Rows 17-19: Percent reductions in oil use for Class 7 and 8 and Classes 3 through 6
- Rows 20-29: Carbon emissions summary; including total generated, savings by Market Segment, Total savings, and percentage savings. These are full fuel cycle savings.
- Rows 30-37: Vehicle Miles Traveled by Market Segment

- Rows 38-44: Future fuel economy for all new truck sales by Market Segment
- Rows 45-51: Technology market penetrations by segment, based on vehicle miles traveled
- Rows52-59: "Fleet" or Vehicle Stocks by Market Segment.

Exhibit ES-9: VT Benefits Results in Tabular Format

	Characteristic	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050	Notes
1	Oil Use Class 7- 8-Combination Unit Trucks, mmbpd	1.682	1.908	2.104	2.303	2.502	2.833	2.974	3.174	3.339	3.498	
2	Oil Use Class 7- 8-Single Unit Trucks, mmbpd	0.299	0.348	0.381	0.417	0.439	0.466	0.474	0.489	0.503	0.518	
3	Oil Use Class 7- 8-Hybrid Trucks, mmbpd	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
4	Oil Use Total, Class 7-8, mmbpd	1.982	2.256	2.485	2.719	2.941	3.298	3.448	3.663	3.842	4.017	
5	Oil Use Class 3-6 Diesel, mmbpd	0.252	0.279	0.316	0.361	0.412	0.469	0.493	0.518	0.540	0.565	
6	Oil use Class 3-6 Gasoline, mmbpd	0.105	0.101	0.107	0.117	0.130	0.147	0.155	0.161	0.166	0.171	
7	Oil Use Total Class 3-6, mmbpd	0.357	0.380	0.423	0.477	0.543	0.615	0.648	0.679	0.706	0.736	
8	Total Oil Use, mmbpd	2.339	2.636	2.908	3.196	3.483	3.914	4.096	4.342	4.548	4.752	
9	Class 7- 8-Combination (Type 1) Reduction, mmbpd	0	0.000	0.000	0.095	0.267	0.448	0.569	0.658	0.715	0.748	
10	Class 7- 8-Single Unit (Type 2) Reduction, mmbpd	0	0.000	0.000	0.012	0.035	0.060	0.079	0.094	0.106	0.111	
11	Class 7- 8-Hybrid (Type 3) Reduction, mmbpd	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
12	Class 7-8 Oil Reduction, Total mmbpd	0.000	0.000	0.000	0.107	0.302	0.508	0.648	0.752	0.821	0.859	
13	Oil Reduction Class 3-6 Diesel, mmbpd	0	0.000	0.001	0.011	0.022	0.030	0.037	0.043	0.047	0.049	
14	Oil Reduction Class 3-6 Gasoline, mmbpd	0	0.000	0.000	0.004	0.012	0.019	0.024	0.027	0.028	0.029	
15	Class 3-6 Oil Reduction, Total mmbpd	0.000	0.000	0.001	0.015	0.034	0.050	0.061	0.070	0.075	0.077	
16	Total Oil Reduction, mmbpd	0.000	0.000	0.001	0.122	0.336	0.557	0.709	0.822	0.896	0.936	
17	Oil Reduction Class 7-8, %	0%	0%	0%	4%	10%	15%	19%	21%	21%	21%	
18	Oil Reduction Class 3-6, %	0%	0%	0%	3%	6%	8%	9%	10%	11%	10%	
19	Total Oil Reduction, %	0%	0%	0%	4%	10%	14%	17%	19%	20%	20%	
20	Total Carbon Emissions, mmtce	133.85	150.87	166.44	182.94	199.36	223.99	234.43	248.51	260.31	272.00	
21	Carbon Reduction Class 7- 8-Combination(Type 1), mmtce	0.0	0.0	0.0	5.4	15.3	25.7	32.6	37.7	41.0	42.9	
22	Carbon Reduction Class 7- 8-Single Unit (Type 2), mmtce	0.0	0.0	0.0	0.7	2.0	3.4	4.5	5.4	6.0	6.3	
23	Carbon Reduction Class 7- 8-Hybrid (Type 3), mmtce	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
24	Total Carbon Reduction Class 7-8, mmtce	0.0	0.0	0.0	6.1	17.3	29.1	37.1	43.1	47.0	49.2	
25	Carbon Reduction Class 3-6 Diesel, mmtce	0.0	0.0	0.0	0.6	1.3	1.7	2.1	2.5	2.7	2.8	
26	Carbon Reduction Class 3-6 Gasoline, mmtce	0.0	0.0	0.0	0.2	0.7	1.1	1.3	1.5	1.6	1.6	
27	Total Carbon Reduction Class 3-6, mmtce	0	0	0	1	2	3	3	4	4	4	
28	Total Carbon Reduction, mmtce	0.0	0.0	0.0	7.0	19.2	31.9	40.6	47.1	51.3	53.6	
29	Total Carbon Reduction, %	0%	0%	0%	4%	10%	14%	17%	19%	20%	20%	
30	Vehicle Miles Traveled Class 7-8, Combination; milliions	149,899	171,849	192,962	217,088	243,882	276,584	292,883	317,381	340,368	363,879	
31	Vehicle Miles Traveled Class 7-8, Single Unit; mllions	29,848	35,105	38,932	42,494	44,595	47,022	47,984	49,508	51,225	53,279	
32	Vehicle Miles Traveled Class 7-8, Hybrid; millions	0	0	0	0	0	0	0	0	0	0	
33	Total Class 7-8, billions	180	207	232	260	288	324	341	367	392	417	
34	Vehicle Miles Traveled Class 3-6, Diesel, milliions	34,894	39,266	44,766	51,296	59,018	67,775	75,848	82,625	86,939	87,745	
35	Vehicle Miles Traveled Class 3-6, Gasoline, millions	15,101	14,617	15,676	17,230	19,270	21,642	23,895	25,815	27,050	27,255	
36	Total Class 3-6 , billions	50	54	60	69	78	89	100	108	114	115	
37	Total Vehicle Miles Traveled , millions	230	261	292	328	367	413	441	475	506	532	
38	Fuel Economy Class 7-8, Combination, mpg	6.09	6.09	6.11	7.28	8.02	8.03	8.05	8.09	8.11	8.13	
39	Fuel Economy Class 7-8, Single Unit, mpg	6.69	6.69	6.72	6.96	7.22	7.24	7.24	7.25	7.26	7.27	
40	Fuel Economy Class 7-8, Hybrid, mpg	6.69	6.69	6.69	6.69	6.69	6.69	6.69	6.69	6.69	6.69	
41	Average, Class 7-8, mpg	6.15	6.15	6.17	7.24	7.93	7.94	7.96	8.00	8.01	8.03	
42	Fuel Economy Class 3-6, Diesel, mpg	9.31	9.31	9.34	10.33	10.86	11.37	11.83	11.84	11.85	11.89	
43	Fuel Economy Class 3-6, Gasoline, mpg	8.83	8.83	8.84	9.31	10.39	10.39	10.39	10.39	10.40	10.40	
44	Average, Class 3-6, mpg	9.21	9.22	9.26	10.55	11.05	11.23	11.52	11.53	11.54	11.58	
45	Market Penetration Class 7-8, Combination, % VMT	0.0%	0.1%	1.6%	46.2%	68.0%	68.3%	68.9%	70.1%	70.4%	71.1%	
46	Market Penetration Class 7-8, Single Unit, % VMT	0.0%	0.1%	1.8%	11.5%	22.0%	22.8%	23.0%	23.3%	23.6%	23.9%	
47	Market Penetration Class 7-8, Hybrid, % VMT	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
48	Market Penetration--All Types, Class 7-8, % VMT	0.0%	0.1%	1.6%	42.6%	63.3%	63.7%	64.2%	65.3%	65.7%	66.2%	
49	Market Penetration Class 3-6 Gasoline, % VMT	0.0%	0.0%	2.5%	37.1%	48.6%	48.7%	48.7%	48.7%	48.8%	49.0%	
50	Market Penetration Class 3-6 Diesel, % VMT	0.0%	0.6%	2.8%	42.5%	55.9%	61.4%	69.9%	70.1%	70.5%	71.5%	
51	Market Penetration All types Class 3-6 , % VMT	0.0%	0.5%	2.7%	41.5%	54.5%	58.9%	65.8%	66.0%	66.2%	67.1%	
52	Vehicle Stock Class 7-8, Combination, vehicles x 1000	4	4	4	5	5	5	5	6	6	6	
53	Vehicle Stock Class 7-8, Single Unit, Vehicles x 1000	1	2	2	2	2	2	2	2	2	2	
54	Vehicle Stock Class 7-8, Hybrid, Vehicles x 1000	0	0	0	0	0	0	0	0	0	0	
55	Total Vehicle Stock Class 7-8, Vehicles X 1000000	4.94	5.58	6.04	6.45	6.73	7.02	7.31	7.63	8.02	8.50	
56	Vehicle Stock Class 3-6, Diesel, x 1000	2.80	2.96	3.07	3.22	3.38	3.56	3.68	3.82	3.97	4.12	
57	Vehicle Stock Class 3-6, Gasoline, x 1000	1.45	1.53	1.59	1.67	1.75	1.84	1.91	1.98	2.06	2.13	
58	Total Vehicle Stock Class 3-6, Vehicles X 1000000	4.25	4.49	4.67	4.89	5.13	5.40	5.58	5.80	6.03	6.25	
59	Total Vehicle Stock, Vehicles X 1000000	9.18	10.07	10.70	11.34	11.85	12.43	12.89	13.43	14.05	14.75	

Exhibit ES-10 is a similar summary of results. Consumption and Carbon emissions effects are shown by Technology contribution.

Exhibit ES-10: VT Benefits Results Showing Effects by Technology

	Characteristic	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
	Consumption Breakdown, mmbpd										
1	Oil Use Class 7- 8-Combination Unit Trucks, mmbpd	1.682	1.908	2.104	2.303	2.502	2.833	2.974	3.174	3.339	3.498
2	Oil Use Class 7- 8-Single Unit Trucks, mmbpd	0.299	0.348	0.381	0.417	0.439	0.466	0.474	0.489	0.503	0.518
3	Oil Use Class 7- 8-Hybrid Trucks, mmbpd	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	Oil Use Total, Class 7-8, mmbpd	1.982	2.256	2.485	2.719	2.941	3.298	3.448	3.663	3.842	4.017
5	Oil Use Class 3-6 Diesel, mmbpd	0.252	0.279	0.316	0.361	0.412	0.469	0.493	0.518	0.540	0.565
6	Oil use Class 3-6 Gasoline, mmbpd	0.105	0.101	0.107	0.117	0.130	0.147	0.155	0.161	0.166	0.171
7	Oil Use Class 3-6	0.357	0.380	0.423	0.477	0.543	0.615	0.648	0.679	0.706	0.736
8	Total Oil Use, mmbpd	2.339	2.636	2.908	3.196	3.483	3.914	4.096	4.342	4.548	4.752
9	Class 7 & 8 Savings Breakdown, mmbpd										
10	Oil Reduction Class 7- 8-Auxiliary Load Reduction	0	0.000	0.000	0.003	0.008	0.013	0.017	0.020	0.022	0.023
11	Idle Hour Reduction	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	Oil Reduction Class 7- 8--Engine Efficiency/WHR	0	0.000	0.000	0.092	0.261	0.438	0.560	0.649	0.709	0.742
13	Oil Reduction Class 7- 8--Vehicle Weight Reduction	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14	Oil Reduction Class 7- 8-Aerodynamic Load Reduction	0	0.000	0.000	0.012	0.033	0.056	0.066	0.083	0.091	0.095
15	Class 7-8 Oil Reduction, Total mmbpd	0.000	0.000	0.000	0.107	0.302	0.508	0.648	0.752	0.821	0.859
16	Oil Reduction Class 3-6-Auxiliary Load Reduction	0	0.0000	0.000	0.001	0.002	0.003	0.004	0.004	0.005	0.005
17	Oil Reduction Class 3-6--Engine Efficiency/WHR	0	0.0000	0.001	0.014	0.031	0.045	0.056	0.064	0.069	0.071
18	Oil Reduction Class 3-6--Vehicle Weight Reduction	0	0.0000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
19	Oil Reduction Class 3-6-Aerodynamic Load Reduction	0	0.0000	0.000	0.000	0.001	0.001	0.001	0.001	0.002	0.002
20	Oil Reduction Class 3-6-Hybrid	0	0.0000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
21	Oil Reduction Class 3-6, mmbpd	0.000	0.000	0.001	0.015	0.034	0.050	0.061	0.070	0.075	0.077
22	Total Oil Reduction, mmbpd	0.000	0.000	0.001	0.122	0.336	0.557	0.709	0.822	0.896	0.936
27	Oil Reduction-Auxiliary Load Reduction	0.0%	0.0%	0.0%	0.1%	0.3%	0.4%	0.5%	0.6%	0.6%	0.6%
28	Idle Hour Reduction	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
29	Oil Reduction--Engine Efficiency/WHR	0.0%	0.0%	0.0%	3.3%	8.4%	12.4%	15.0%	16.4%	17.1%	17.1%
30	Oil Reduction--Vehicle Weight Reduction	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
31	Oil Reduction-Aerodynamic Load Reduction	0.0%	0.0%	0.0%	0.4%	1.0%	1.5%	1.6%	1.9%	2.0%	2.0%
32	Oil Reduction-Hybrid	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
33	Total Oil Reduction, %	0%	0%	0%	4%	10%	14%	17%	19%	20%	20%
34	Total Carbon Emissions, Diesel	72.929	143.79	158.73	174.46	189.90	213.43	223.34	236.91	248.30	259.55
35	Total Carbon Emissions, Gas	7.022	7.080	7.703	8.483	9.457	10.561	11.095	11.595	12.009	12.447
36	Total Carbon Emissions, mmtce	133.85	150.87	166.44	182.94	199.36	223.99	234.43	248.51	260.31	272.00
37	Carbon Emissions-Auxiliary Load Reduction, mmtce	-	-	0.00	0.18	0.51	0.84	1.07	1.24	1.35	1.41
38	Carbon Reduction--Engine Efficiency/WHR, mmtce	-	-	0.04	6.01	16.59	27.52	35.04	40.63	44.28	46.26
39	Carbon Reduction--Vehicle Weight Reduction, mmtce	-	-	-	-	-	-	-	-	-	-
40	Carbonl Reduction-Aerodynamic Load Red., mmtce	-	-	0.00	0.77	2.12	3.52	4.48	5.19	5.66	5.91
41	Carbon Reduction-Hybrid, mmtce	-	-	-	-	-	-	-	-	-	-
42	Total Carbon Reduction, mmtce	0.0	0.0	0.0	7.0	19.2	31.9	40.6	47.1	51.3	53.6
43	Total Carbon Reduction, %	0%	0%	0%	4%	10%	14%	17%	19%	20%	20%

1.0 Introduction

This report describes the approach to estimating the benefits and analysis results for the Heavy Vehicle Technologies activities of the Vehicle Technologies (VT) Program of EERE. The scope of the effort includes:

- Characterizing baseline and advanced technology vehicles for Class 3 – 6 and Class 7 and 8 trucks,
- Identifying technology goals associated with the DOE EERE programs,
- Estimating the market potential of technologies that improve fuel efficiency and/or use alternative fuels,
- Determining the petroleum and greenhouse gas emissions reductions associated with the advanced technologies.

In FY 08 the Heavy Vehicles program continued its involvement with various sources of energy loss as compared to focusing more narrowly on engine efficiency and alternative fuels. These changes are the result of a planning effort that first occurred during FY 04 and was updated in the past year. (Ref. 1)

This narrative describes characteristics of the heavy truck market as they relate to the analysis, a description of the analysis methodology (including a discussion of the models used to estimate market potential and benefits), and a presentation of the benefits estimated as a result of the adoption of the advanced technologies. The market penetrations are used as part of the EERE-wide integrated analysis to provide final benefit estimates reported in the FY08 Budget Request. The energy savings models are utilized by the VT program for internal project management purposes.

2.0 Background

This analysis of the benefits expected from achieving the Heavy Vehicle Technologies Program goals was developed based on three primary reference sources:

- For vehicle characteristics and use information—the 2002 Vehicle Inventory and Use Survey (VIUS). This provides information on both vehicle performance characteristics, such as fuel economy, vehicle characteristics and use patterns such as miles traveled per year. (Ref. 2)
- For truck operator investment decision criteria—a survey of Owner-Operators performed by the American Trucking Associations in 1995. (Ref. 3)
- Vehicle performance and cost characteristics for advanced technologies—from information provided by and discussions with the EERE Program Managers.

Important "background" information such as energy prices and baseline technology fuel economies are based on the Annual Energy Outlook (Reference Case) prepared by the Energy Information Administration. (Ref. 4)

3.0 Target Markets

The analysis considers trucks included in the standard gross vehicle weight classes 3 through 8 (10,001 lb. to greater than 33,001 lb.). These are generally referred to as "Heavy Vehicles". For purposes of analysis, these trucks are grouped into two *classifications*: those within Classes 3 through 6, which are designated Medium Trucks and those within Classes 7 and 8 which are designated Heavy Trucks. Medium Trucks include all highway trucks in the weight range of 10,001 lb to 26,000 lb. Heavy Trucks include all heavier trucks used on highways. While there is a wide diversity of truck sizes and weights, nearly 60% of all Class 3-6 trucks are in Class 6 and over 92% of Class 7&8 trucks are in Class 8. (Ref. 5)

VIUS data were examined for all vehicles in use and vehicles two years old or less. The Heavy Truck market (Classes 7 and 8) was parsed into two types. The specific vehicle configurations have widely varying annual vehicle mileage traveled patterns. The vehicle market segments are made up of the vehicle configurations listed below:

- Combination Units – These consist of the separate motorized tractor and box trailer units. This configuration heavily dominates the Class 7 and 8 market segment.
- Single Units – These vehicles consist of the cab and freight-carrying box or bed mounted on a combined chassis.

While heavy vehicle sales data and sales projections are available, projections of sales by market segments are not available. The estimates used in this analysis are based on a survey of current uses and assumes that future uses will remain approximately the same.

The lower annual mileage and resulting lower average speed characteristics of single unit trucks greatly reduce the potential efficiency benefits in that segment compared to combination unit trucks. For similar reasons, fuel economy improvements due to speed-dependent measures such as improved aerodynamics and electricification will have lower benefit in single units than in the combination units.

Distances traveled by combination unit vehicles are typically greater than single units, implying that the typical speeds are higher. These characteristics make them a somewhat better market sector for measures that perform in relation to speed such as advanced tires.

Refueling characteristics; i.e. central-source refueling or non-central source also are considered in the market characteristics, as centrally-refueled vehicles would find an alternative fuel source more practical than vehicles that always refuel at road-side facilities.

Eleven travel distance categories for medium trucks and twenty-one for heavy trucks are represented in the model. These categories were determined using travel distributions developed with the VIUS data by ORNL. (Refs. 2, 6)

Exhibit 1 shows the distribution of annual travel for Class 3 through 6 and Class 7 & 8 vehicles. Combination Units vehicles display the greatest amount of annual travel of all heavy vehicle classes as is evidenced in part by the curve's peaking in the 120,000 to 139,000 mile segment.

Exhibit 2 shows the vehicle use pattern for Single Unit Heavy trucks. The distribution based both on vehicles and vehicle-miles traveled are indicated.

The contrast in vehicle usage distribution is evident when Exhibits 2 and 3 are compared. Almost 35% of the single unit vehicles travel 7,500 miles per year, but more than 30% of the vehicle miles are contributed by vehicles traveling between 22,000 and 32,000 miles per year. Exhibit 3 shows the same information as Exhibit 2—but for Combination Units trucks. For Combination Units, the peak travel segment is 127,000 miles per year, by more than 12% of the vehicles.

Centrally-refueled and non-centrally fueled vehicle use characteristics have also been analyzed. Centrally refueled vehicles travel less per year than non-centrally refueled vehicles. In the non-centrally refueled vehicle segment, the highest portion of vehicle use occurs traveling 25,000 miles per year. In the central refueling segment, usage peaks occur at points—20,000 and 100,000 miles per year.

3.1 Key Factors Affecting Market Adoption of Technology

Based on a survey conducted by the American Trucking Associations, energy conservation purchase decisions for this sector are significantly affected by economic viability—specifically the payback of the investment. (Ref. 3) The survey of 224 motor carriers revealed that paybacks of one to four years were acceptable for energy conserving technologies. Based on those findings, we model the market acceptance of the various technologies based on payback performance.

Exhibit 1:
Annual Travel Patterns—Combination and Single Unit Heavy Trucks

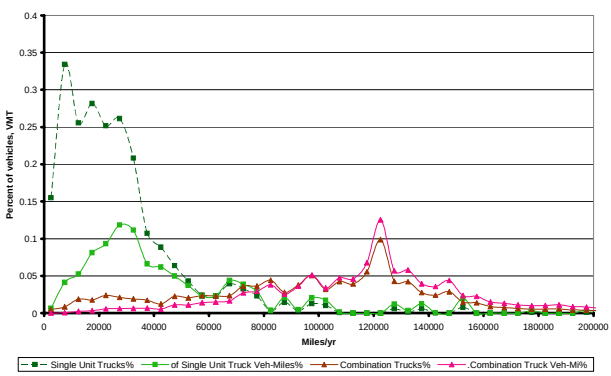


Exhibit 2:
Single Unit Vehicle Use

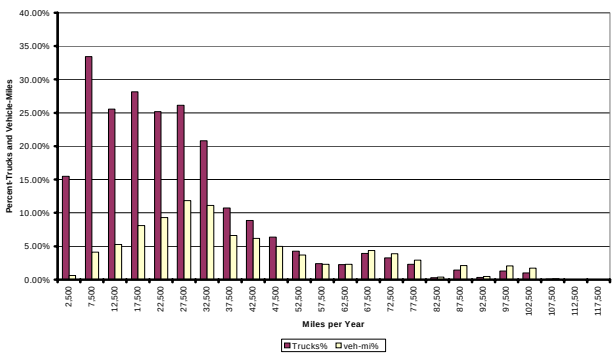
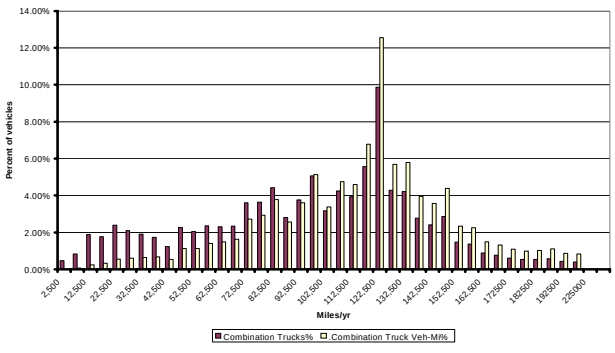


Exhibit 3:
Combination Unit Vehicle Use



3.1.1 Effects of Lower Emissions on Heavy Vehicle Fuel Economy

The Environmental Protection Agency (EPA) regulates emissions from heavy-duty engines and trucks. This is changing engine technology. Some reduction in fuel economy with the new engines is expected as the combustion process is optimized to address emissions reduction. These changes will impose both operating and capital costs on truck operators. Emissions standards for diesel engines used in heavy trucks in 2004 were 4 g/bhp-hr for NO_x and 1.3 g/bhp-hr for Hydrocarbons (HC).

Major elements of the EPA rules include the following:

- Reduction of nitrogen oxides (NOx) and fine particulate matter $PM_{2.5}$ from new heavy-duty highway diesels (e.g., trucks and buses) by about 90%, effective in 2007 for PM and 2007-2010 for NOx.
- Reduction of the sulfur content in highway diesel fuel to 15 ppm ("ultra-low sulfur diesel" fuel, or "ULSD" fuel) beginning in late 2006.
- Similar reductions of nitrogen oxides (NOx) and fine particulate matter $PM_{2.5}$ from new heavy-duty non-road diesels (e.g., construction, farming and logging equipment) will be required in the 2011-2014 timeframe.
- Reduction of the sulfur content in diesel fuel used in stationary engines will occur in two steps, to 500 ppm in 2007 and 15 ppm beginning in 2010. Sulphur in fuel for locomotive and many marine engines will be reduced to the same levels in two steps. However, the date for making the 15 ppm fuel available is 2012.

The EPA rule-making process includes a cost analysis for the technologies required to meet the new standards. The cost estimates for the new emission control technologies assumed that fuel injection and turbocharger improvements needed would happen without the new standards. So in estimating increases in engine costs, the EPA excluded 50 percent of the technology cost from the total estimated cost. Thus the EPA estimated that the incremental costs for heavy-duty engines to meet the standard would be at $803 in 2004, decreasing to $368 in 2009. The EPA also estimated the increase in annual operating cost for heavy-duty engines to be $104 for the maintenance of the exhaust gas recirculation (EGR).

The effect of additional equipment that is used for treating emissions was also considered. The added weight of the equipment requires additional horsepower output from the engine, which results in a reduction in fuel efficiency. The EPA expects NOx adsorbers to be the most likely emission control technology applied by the industry. NOx adsorber regeneration will require small injections of diesel fuel for ‘light off’ and desorption of stored NO for downstream catalysis under rich-burn conditions. This is expected to result in additional fuel use beyond combustion for propulsion of 2-4%. Additional reduction in efficiency is anticipated due to control of sulfur-containing emissions. (Refs. 7, 8, 9)

The effects of the more stringent regulations are considered implicitly in the fuel economy assumptions for the baseline engines, which affects the payback analysis.

3.1.2 Market Developments Relating to the New EPA 07 Diesel Engine Emissions Standards

As of January 1, 2007 the EPA's new diesel engine emissions standards went into effect. A brief discussion of the approaches developed by heavy truck engine manufactures as well as new truck sales is presented below.

Prior to the new standards, sales increased as buyers were trying to purchase trucks before costs increased. Mack Truck (which is owned by Volvo) had a 54 percent drop in deliveries in the time period of July 2006 to July 2007. Prices of the new trucks were increasing as much as 7½% during this period. Buyers were reported to be worried about the reliability and maintenance requirements of the new truck emissions control systems. (Ref. 10) Volvo also has experienced a decrease in sales. Their shipments to North America fell 60 percent for the first seven months of 2007 as opposed to the same time period in 2006. (Ref 11) Industry experts believe that the slump will last until the end of 2008 and start to increase in 2009. However there is speculation that the emissions standards scheduled for 2010 will cause another cycle of increased sales before the engines and vehicles compliant with these standards are being sold, followed by a sharp drop in sales.

Caterpillar developed an approach that utilizes two processes to comply with the regulations. (Ref 12) One process is called Clean Gas Induction. A small amount of non-combustible gas is drawn off, after it passes the vehicle's aftertreatment system. The gas is cooled, mixed with more incoming clean air and returned to the combustion chamber. The non-combustible gas is a product of efficient combustion and it is extracted after it has passed through the second part of the treatment system, a Diesel Particulate Filter (DPF). The result is that contaminants are removed before the gas re-enters the intake system.

The DPF is a design exclusive to Caterpillar and it replaces its own Diesel Oxidation Catalyst which was previously used on their engines. The DPF operates in conjunction with a self-contained Regeneration System that rids the filters of all the accumulated soot. The regenerator includes an electronic control module and when it detects soot build-up, the regeneration is initiated. The system can work under any operating condition and uses only the fuel necessary to oxidize the soot. There is no driver action required. The removal of ash is needed every 200,000 to 300,000 miles.

Mack also utilizes two new technologies. (Ref 13) The first one is High Efficiency Exhaust Gas Recirculation (HEGR) which controls and reduces NO_x formation. The hot exhaust passes through the EGR valve after exiting the exhaust manifold. While the majority of the gas is exhausted from the system, the EGR valve diverts a measured amount into the EGR system. The cooled exhaust gas is mixed with filtered inlet air. This dilutes the oxygen introduced into the engine, which lowers the combustion temperature and reduces the amount of NO_x produced. The combined exhaust and inlet air enters the engine's cylinders where it is mixed with fuel and combusted.

Mack also has its own variation of a catalyzed DPF, called the "Mack Capsule," that will trap Particulate Matter (PM). There are two ceramic (corderite) elements inside the DPF. The first contains a three-inch thick proprietary platinum coated oxidation catalyst. It can change some of

the hydrocarbons in the exhaust into carbon dioxide and water vapor. The second element is the actual particulate or soot trap. It is about 12" in diameter by 15" deep and is a "through the wall" flow design. The soot particles are trapped or captured within the filter wall. Their DPF system also oxidizes the soot, leaving a fine residual ash, by a process called Regeneration. This occurs in either active or passive form. The Passive Regeneration is performed primarily by the DPF system. The soot is oxidized out of the DPF by an ongoing catalytic reaction that uses no additional fuel. The catalytic reaction is requires exhaust temperatures greater than 600^{o}F, which is typically generated during normal operation of the engine. The process is designed to be simple, quiet, effective, and fuel efficient.

"Active" Regeneration will occur when the engine doesn't generate high enough exhaust temperatures at a constant rate. In active regeneration, a small mist of diesel fuel is injected into the exhaust system at the turbocharger outlet; the mist travels through the exhaust pipe to wet the DPF's pre-catalyst. This will cause a chemical reaction which raises DPF temperatures to the level required to convert the soot into CO_2. Active regeneration takes about 15 minutes and is not noticeable to the driver. The event will occur automatically when sensors on the DPF let the engine computer know that the particulate trap is becoming full. Like passive regeneration, fine ash residual remains trapped in the DPF which is cleaned out during regular maintenance services. Mack expects the DPF to go more than 150,000 miles before its first cleaning, then it is expected to need cleaning at intervals of 250,000 miles thereafter.

While not currently employed in truck applications, in March 2007, the EPA released a Document of Guidance for using Selective Catalytic Reduction (SCR) technology (Ref. 14). SCR reduces NOx by introducing an agent such as a water-based urea solution into the high temperature exhaust stream of any engine. The liquid agent is stored in an onboard tank and injected upstream of the SCR catalyst. The EPA document is applicable to the implementation of SCR in the 2010 heavy-duty engines, which is anticipated in order to achieve the requirements for the 2011-2014 time period.

One issue that the EPA addressed was the availability of urea. If the vehicle operates without any urea, the SCR catalyst becomes inactive which could lead to higher NO_x emissions. The EPA now requires that manufacturers have plans for urea availability. Specially, the urea should be available at dealerships and truckstops. The Guidance Document also requires a back-up option, such as a toll-free number so that the customers can call if they cannot find any urea. The document calls for the manufacturers to "use best efforts" to make sure the dealers maintain an adequate supply of urea.

The more stringent emissions standards have caused some effects in the market, which was anticipated. However, the technologies developed or being developed represent relatively minor changes to the traditional engine and vehicle systems.

3.2 Market Segmentation Analysis

Heavy vehicle characteristics used in the analysis are summarized in Exhibit 4. In the medium truck market segment, Classes 3 through 6, gasoline-fueled vehicles travel an average of just under 12,000 miles per year, while diesel-engine trucks travel an average of 23,000 miles per year. Heavy trucks, depending on type, travel an average of 13,000 miles to 92,000 miles per year, based on the 2002 VIUS data. (Ref. 15)

Exhibit 4: Heavy Vehicle Characteristics

Summary of Heavy Truck Market Characteristics

Vehicle Type	Class 7 & 8	Class 7 & 8	Class 3 through 6 Diesel	Class 3 through 6 Gasoline	Comments
Body Types	Combination Units	Single Units	- -	- -	
Fuel Economy (Baseline)	6.10	6.70	8.90	9.40	
Fuel Economy Improvement, %	155%	150%	145%	144%	Combined effect of FCVT Technologies, 2020-2050
Average Miles Traveled, miles	96,300	13,000	23,100	11,800	
Portion of Heavy Truck Fuel Use, %	72%	13%	11%	4%	Estimated--Year 2005
Portion of Vehicle Travel < 50 k Miles, %	5%	68%	84%	98%	
Portion of Vehicle Travel 50 k to 100 k Miles, %	26%	25%	12%	2%	
Portion of Vehicle Travel >100 k Miles, %	69%	7%	4%	0%	

Source notes: Source for Class 7-8, Type 1 is spreadsheet in Heavy Truck Validation Working Group/ Benefits Analysis Briefing-05/06 subdirectory
Source for Class 7-8, Type 2 is spreadsheet in Heavy Truck Validation Working Group/ Benefits Analysis Briefing-05/06 subdirectory
Source for Class 3 through 6 is Heavy Truck Medium Diesel Pls Gas spreadsheet in the same subdirectory

In addition to the market characterization, historical market penetration data was obtained from VIUS surveys for energy conserving technologies including radial tires, aerodynamic devices, and fan clutches. This data was utilized in the calibration of the rate of efficiency technology adoption in the models discussed in Section 4.

4.0 Heavy Vehicle Benefits Analysis

4.1 Vehicle Technology Characterizations

The TRUCK Model which is used to estimate the market penetration of heavy vehicle technologies supported by DOE, uses a payback algorithm. The model, which is further described in Section 4.4, requires inputs of fuel efficiency improvement and technology cost on an annual basis. The model estimates market penetrations over a fifty (50) year period.

Fuel economy improvements were quantified in an iterative process that started with a review of the Vehicle Technologies (VT) Program Plan. (Ref. 1) Technologies that address engine efficiency, auxiliary and accessory load reduction, vehicle system improvements (e.g. improved aerodynamics and tires) are included in the FCVT program. The program plan provides estimates of the potential fuel economy benefits of various technologies individually, but it does not address the expected interactions between the various technologies as they are grouped together in various vehicles and end-use applications. For that, we use the Heavy Truck Energy Balance Model (HTEB) further described in Section 4.3

The program plan further does not provide technology cost estimates. Therefore, a 'price goal' approach was used by the project team in which incremental cost equivalent to a two-year payback for the technology was used as the basis for the cost inputs. Price reductions were assumed over time as the technology matures and production levels increase.

Exhibit 5 summarizes the fuel economy improvement and price assumptions used for the Benefits Analysis.

Exhibit 5: Heavy Vehicle Technologies GPRA 08 Inputs

	Characteristic	2010	2020	2030	2040	2050
1	Fuel Economy Class 7-8, Combination Unit mpg Multiplier	1.29	1.55	1.55	1.55	1.55
2	Fuel Economy Class 7-8, Single Unit mpg Multiplier	1.28	1.50	1.50	1.50	1.50
3	Fuel Economy Class 3-6 Gasoline, mpg Multiplier	1.24	1.45	1.45	1.45	1.45
4	Fuel Economy Class 3-6-Diesel, mpg Multiplier	1.24	1.44	1.44	1.44	1.44
5	Class 7-8, Iincremental Cost, $	$ 30,000	$ 15,000	$ 10,000	$ 10,000	$ 10,000
6	Class 3-6 Gasoline, Incremental Cost, $	$ 5,000	$ 2,000	$ 1,500	$ 1,500	$ 1,500
7	Class 3-6 Diesel, Incremental Cost, $	$ 7,500	$ 2,500	$ 2,000	$ 2,000	$ 2,000

4.2 Overview of Models and Analysis Methodology

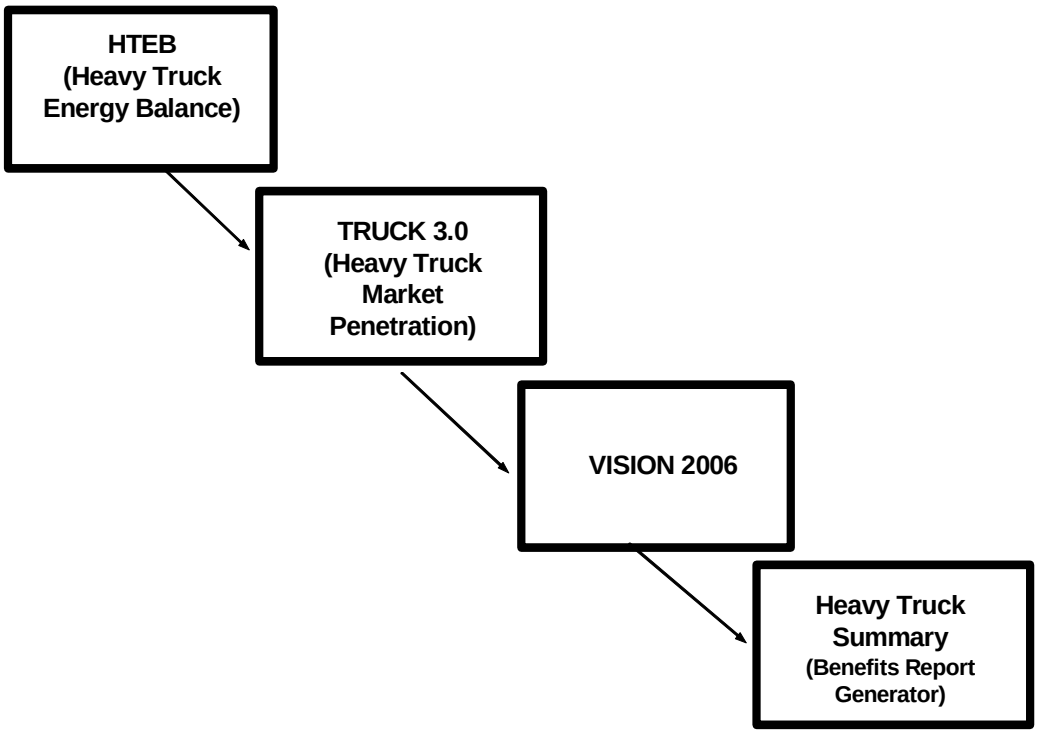
The analysis of the benefits expected from achieving the Heavy Vehicle technologies program goals is described in this section.

Initial benefits estimates are generated through the linkage of four spreadsheet models:

- HTEB--Heavy Truck Energy Balance Model
- TRUCK 2.0--Heavy Vehicle Market Penetration Model. Pages from this model are reproduced in the Appendix
- VISION 2007, and
- Heavy Truck Summary (HvyTrkSum) report generator.

The relationship of these four models is indicated in Exhibit 6[1].

Exhibit 6: Heavy Truck Benefits Analysis Models



[1] The HTEB was developed by William Shadis and James Moore of TA Engineering.

The TRUCK (2.0) Model was developed as a collaborative effort, initially by John Maples of Oak Ridge National Laboratory (ORNL), with assistance from James Moore, of TA Engineering, Inc. Subsequent enhancements have been performed by Moore and Shadis (TA Engineering).

The VISION model was developed by Margaret Singh and Anant Vyas of ANL.

The Heavy Vehicle Summary Model is a report generating spreadsheet. It was initially developed by Maples, and has subsequently been modified by Analysts at the National Renewable Energy Laboratory, and TA Engineering.

4.3 Heavy Truck Energy Balance Model (HTEB)

The Heavy Truck Energy Balance Model was developed to assess the overall fuel economy effect of several changes to the vehicle involving the engine, drive train and other elements. It was developed by TA Engineering after initial investigations and conversations with FCVT personnel confirmed that vehicle simulation models for heavy trucks were not available in the public domain. The spreadsheet model considers energy losses based on user-selected inputs of vehicle characteristics and use. It is a steady-state model.

Analyses were performed and HTEB Models compatible with the vehicle characteristics for the Single Unit and Combination Unit Class 7 & 8, and Class 3 through 6 vehicles were developed. Vehicle characteristics and use parameters evaluated in the development of the model include the following:

- Truck weight
- Engine Idle Time (Ref. 16)
- VIUS fuel economy values for Heavy and Medium Trucks using estimates of average speed and average stops/hour.
- Aero CD reductions (more than 20%)
- Engine efficiency increases of 10% and 37.5%. Engine efficiency was assumed to be the net output from the engine including the effects of internal friction as well as normal engine accessories (fuel pump, water pump, etc.).
- Engine-driven accessories (fuel pump, oil pump, coolant pump, fan) - the average load was decreased 80% to account for the fact that these units can be energized electrically to avoid over-powering that occurs with engine drive belts at normal engine speeds.

Users can specify truck power to solve for energy balance (engine energy output adequate to overcome losses and driving loads), and therefore fuel economy. The Model calculates part-load efficiency effects, and includes an idling energy calculation (percent of operating hours—a user definable input). Aerodynamic and Rolling resistance calculations are included in the model based on the selected vehicle characteristics. Braking energy use and recovery calculations are also performed.

For each Class 7 and 8 Type and for Medium Trucks, the Program Plan baseline fuel economy was replicated (modified to match VIUS usage patterns) and used as the baseline to which the program technologies were applied. Individual technology areas were modeled as ‘single’ point changes, and all improvements were combined. The vehicle system and driving loads act in a multiplicative manner, so the product of the individual benefits assumed is the overall benefit. This is how the fuel economy multipliers shown previously in Exhibit 5 were determined.

The principal user spreadsheet of the Heavy Truck Energy Benefits Model is reproduced as Exhibit 7. Additional information on this model is presented in Reference 17.

Exhibit 7: Truck Energy Balance Model

Truck Energy Balance Model Version 2.0 (User's may input alternative values to default items in Blue Font)					
TRUCK POWER TRAIN ENERGY ITEM			**Value**	**Units**	**Notes**
Class 7-8 Combination Unit Case:					
Engine Peak Power Rating			***250***	kW	*1. To develop new configuration, set 'Average Power' = 'Peak Power' (Cell H80)* *2. Perform 'Goal Seek' Operation as described below. This will determine Average Power (Row 5)* *3. Adjust efficiency (G10) and other parameters as needed to achieve performance goal. Repeat 'Goal Seek' Operation to make Remainder = 0 ('H-80) by changing Average Power Rating (H-80).*
Estimated Engine Average Power Rating			*109*	kW	
Assumed Average Truck Speed			48.24	MPH	This is the average speed of the truck for the driving cycle assumed. Linked to 'Type Info' 2. Perform 'Goal Seek 1' Operation as described below.
Estimated Effective Truck Speed			42.00	MPH	Linked to **"Type Info"** page
Fuel Energy Content-LHV			128,700	BTU/gal-LHV	from Transportation Energy Databook
Fuel Energy Content-HHV			138,700	BTU/gal-HHV	from Transportation Energy Databook
Engine Peak Frictionless Efficiency			37.00%		
Percent Full Load			44%		
Cycle Efficiency Factor			94.7%		Accounts for engine efficiency variation at part load
Average Frictionless Cycle Efficiency:			**35.0%**		Assumed engine efficiency at the expected average load-, discounting all friction & based on HHV
Fuel Consumption Rate			1,060,648	BTU/hr	
Fuel Consumption Rate			7.6	gal/hr	
Non-Idle Fuel Economy			6.31	**MPG**	**Calculated**
Average Workday Length:			8.00	**hr**	
Percent of Normal Time Idling			20%		**From 'Type Info' page**
idle Fuel Consumption Rate:			1.00	**gal/hr**	
Idle Fuel Consumption:			1.60	**gal/day**	
Non-Idle Fuel Consumption			48.94	**gal/day**	
Total Fuel Consumption			50.54	**gal/day**	
Overal Average Fuel Economy			**6.11**	**MPG**	
Internal Engine Parasitics	**Factor**	**1.00**	**Efficiency**	**Power Consumed (kW)**	
	% of Engine Full Load Capacity				
Pistons & Rings	**0.50%**			1.3	"
Connecting rod and crankshaft bearings	**1.00%**			2.5	"
Valvetrain/camshaft	**1.00%**			2.5	"
Less Total Internal Engine Parasitics				6.3	Calculated
= Gross Engine-Out Power				**102.6**	Calculated
Gross Power-Out Engine Efficiency				**33.0%**	**This is the nominal "engine efficiency" value**
Engine Accessory Loads	**Factor**	**1.00**	**Efficiency**	**Power Consumed (kW)**	
	% of Engine Full Load Capacity				Based on Gross Engine-Out Power
Fuel injector pump	**1.0%**			2.5	"
Power Steering	**1.0%**			2.5	"
Oil pump	**0.5%**			1.3	"
Coolant pump	**1.0%**			2.5	"
Fan	**1.0%**			2.5	"
					Based on Gross Power--Not in electrification program
Less Total Engine Aux Loads				**11.3**	Calculated
= Net Engine-Out Power				**91.3**	Calculated
Net Engine-Out Power Efficiency				**29.4%**	Calculated
Vehicle Auxiliary Loads	**Avg Load**	**Units**	**Efficiency/ COP**	**Power Consumed (kW)**	
	Factor	**1.00**			
Alternator	**50**	**amp**	**0.8**	1.0	Capacities & efficiencies assumed, loads calculated
Air Conditioner	**1**	**ton**	**2**	1.8	"
Air Brake Compressor	**0.75**	**HP**	**0.5**	1.1	"
Less Total Veh. Aux. Loads				3.9	Calculated
= Net Available Engine Power				**87.5**	Calculated
Net Eff				28.1%	
Drivetrain Parasitics	**1.00**		**Efficiency**	**Power Consumed (kW)**	
Transmission	**1.00%**	**of max power**		2.5	Based on net available engine-out power
Drivesaft	**0.50%**	**of net power**		0.5	"
Axle/Transaxle	**0.50%**	**of net power**		0.5	Select axle/transaxle or differential, but not both
Differential	**0.00%**	**of net power**		0.0	"
Axle & Wheel Bearings	**0.25%**	**of net power**		0.3	"
Brake Drag	**0.25%**	**of net power**		0.3	"
Less Total Drivetrain Parasitics				**4.1**	Calculated
= Net Available Power to Tires				**83.3**	Calculated
Net Engine-Out Power Efficiency				**26.8%**	Calculated
Driving Loads (See 'Aero & Tires' Sheet)				**Power Consumed (kW)**	**See 'Aero & Tires' & Braking Power' Sheets to make changes.**
Aerodynamic Load				28.4	See Aero & Tires Sheet
Tire Rolling Resistance				23.7	See Aero & Tires Sheet
Acceleration/Braking Energy				31.1	Cycle energy consumed by the brakes divided by the driving cycle time. See **'Braking Power'** Sheet
= Total Non-Hybrid Driving Loads				**83.3**	Calculated
Hybrid Power System					
Percent braking energy recovery				**0.0%**	assumed-includes in/out motor/generator and battery charge/discharge efficiency
Net Braking energy lost				31.1	calculated
Adjusted (Hybrid) Total Driving Load				**83.34**	**calculated**
'Goal Seek' Balancing Value			**Remainder**	**0.0**	**This value must = 0 for an energy balance to occur using Excel "goal seek" to solve for = 0**
	mpg	**6.11**	**kW**	**77.0**	**'Goal Seek' Results (Cell 'G-23' Value)**

4.4 TRUCK Model Version 3.0

Excerpts from the inputs used to generate the market penetration estimates are summarized in Exhibit 8. Values for fuel economy improvement and cost are input into **TRUCK (Version 3.0)**. As an example, the TRUCK model input schedule for Combination Units trucks is indicated in Exhibit 8. The first cost of the technology is assumed to reduce, over time, to values in the range of a two-year payback level as a program goal. The model was developed to estimate the potential market impacts of new technologies.

The results generated by this model are:

- Market penetrations, in units of percent of new vehicles sold for each type and class of vehicle, and vehicle miles, and
- Composite fuel economy rating (new mpg) of the vehicles sold.

The relative market penetration rates of the advanced technology vehicle increases with the relative economic benefit and decreases with increases in relative price.

Exhibit 8: Example First Cost and Efficiency Schedule for Advanced Technologies (Combination Units Vehicles)

	Combination Units		*Single Units*	
Year	Non-Hybrid Measures Cost (2003$)	Efficiency Ratio	Non-Hybrid Measures Cost (2003$)	Efficiency Ratio
2006	42,000	1.138	42,000	1.137
2010	30,000	1.289	30,000	1.285
2015	20,000	1.289	20,000	1.285
2020	15,000	1.546	15,000	1.498
2025	10,000	1.546	10,000	1.498
2030	10,000	1.546	10,000	1.498
2035	10,000	1.546	10,000	1.498
2040	10,000	1.546	10,000	1.498
2045	10,000	1.546	10,000	1.498
2050	10,000	1.546	10,000	1.498

Within the TRUCK model, the scope of economic benefit is limited to the promised or potential fuel cost savings derived from improvements in fuel economy or to the switching to a new fuel. Other potential benefits or negative effects, such as a lengthening or shorting of engine or vehicle life, increased or decreased maintenance costs, or changes in the vehicle resale value and the like are not considered within the structure of the model, although it is possible to manually account for such effects within the calculations.

The model includes Class 3-6 (gasoline and diesel) trucks as well as Class 7&8 (heavy) trucks. As discussed previously, Class 7&8 trucks are further subdivided into the Combination and Single Unit configurations, as described above in order to account for different travel and usage patterns. Each of these four vehicle groups are further analyzed based on the statistical mileage cohorts representing categories from 0-20,000 mi/year to 200,000+ mi/year of vehicle travel. In addition, each class and subclass is further subdivided into cohorts that are separately refueled (in dedicated non-public stations) and those that are refueled at public stations. The percentages of vehicles in each type and mileage cohort are used in this analysis.

The annual fuel savings for each class, type, and mileage cohort is calculated for each of the analysis years for a total of eighty-eight separate calculations for each analysis year. The model can simultaneously analyze the baseline fuel economy and up to two additional fuel-savings improvements. Each savings value is then compared to the projected technology cost to determine its payback and market penetration potential. The market penetration potentials of the two improvements are then compared and apportioned based on an assumption of mutual

interaction (the purchase of one technology may exclude or reduce the economic benefit of the second technology). All of these calculations are performed on an iterative basis through the use of Excel macros (stored automatic calculation routines). The overall market penetration rates for each of the two fuel-savings technologies in each analysis year are then calculated based on the percent of vehicles and vehicle-miles in each subgroup. Exhibit 9 shows the payback distribution assumed in the TRUCK model. This payback distribution was generated from the American Trucking Associations' survey described above. (Ref. 3)

Exhibit 9: Heavy Vehicle Payback Period Market Distribution

Number of Years	Percent of Motor Carriers
1	16.4%
2	61.7%
3	15.5%
4	6.4%

TRUCK is a spreadsheet model that currently operates in Excel (Office XP and associated versions). It consists of multiple spreadsheets linked to other models. It is operated by user specifying inputs and then initiating macros that perform iterative calculations to determine market shares by technology in percents of new vehicle sales. The principal model calculation pages are listed below. These are also reproduced in Appendix A, through items 4 and 6, are not included as they have the same format and content as 5. Based on energy use, Combination Units is the market segment of greatest interest. Model work load page descriptions are as follows:

1. **Inputs**-User specifies incremental technology cost and relative fuel efficiency for current and advanced technology (ies). These inputs are specified by year to 2060 and separately for Class 7 & 8 and Classes 3 through 6 vehicles.
2. **Fuel Prices**—Array of fuel price information. Typically linked to other AEO-source files.
3. **Market Data** —Distribution of vehicle usage patterns from 2002 VIUS
4. **Single Units**—Utilizes an Excel macro in which calculations are performed to determine market distribution of conventional and new technologies for "Single Units" Class 7 and 8 vehicles. Calculations are performed separately for centrally refueled and non-centrally refueled vehicles.
5. **Combination Units**—Utilizes an Excel macro in which calculations are performed to determine market distribution of conventional and new technologies for "Combination Units" Class 7 and 8 vehicles. Calculations are performed separately for centrally refueled and non-centrally refueled vehicles.
6. **Med (Medium Truck)**—Utilizes an Excel macro in which calculations are performed to determine market distribution of conventional and new technologies for "Medium", i.e., Class 3 through 6 vehicles. Calculations are performed separately for gasoline and diesel vehicles and for centrally refueled and non-centrally refueled vehicles.
7. **New MPG**—Shows the effect of new technology penetrations on fuel economy by vehicle class.
8. **Market Vehicle Penetration**—Summarizes the market penetration of new technologies in units of new vehicle sales percentage. Lists market shares for each Class 7 & 8 vehicle

type, Class 7 & 8 composite and Classes 3 through 6 (composite). Vehicle market penetration estimates are based on VIUS survey data of vehicles of up to two years in age.

9. **Market Vehicle-Miles Penetration** (VMT) - Market penetration based on percent of annual vehicle miles traveled. Due to the nature of the VIUS data and the payback calculation methodology this provides a somewhat different and more representative market penetration estimate—for purposes of estimating energy savings. The DOE sponsored technologies penetrate in vehicles used more than average, even in the first years of operation.
10. **Detailed Inputs** - Link to **VISION** Model. This is discussed in Section 4.5. Detailed Inputs page are included for both the market penetrations based on "vehicles sold" and "vehicle miles".
11. **Run Macro** – This page shows the sheet at which the users instruct the model to exercise the macros to estimate market penetrations for each of the market segments.

Note that the model calculates two market penetration rates. The first is the percent of vehicles within the class/type category that are expected to be equipped with the new fuel-saving technology. This permits an estimate of the total economic cost impact of the technology (No. of units x cost/unit). The second is the percent of vehicle-miles affected. Since vehicles which preferentially travel greater miles/yr are more likely to be equipped with energy-saving features, the percent of vehicle-miles/year penetration tends to be higher than the percent of number of vehicles penetration, leading to a higher estimate of economic benefit than would have been obtained otherwise.

While the fuel economy estimates used in the TRUCK model are based on those used in the AEO analysis, they are modified to disaggregate the single Class 7 and 8 estimates in the AEO, and to account for market penetrations of advanced technology included in the AEO values. It was determined that more than 54% of the fuel economy improvement in 2030 relative to 2006 is attributed to FCVT-supported technologies. The impacts on the Baseline fuel economy projections for Classes 7 and 8, and 3 through 6 trucks are illustrated in Exhibit 10.

Exhibit 10: Methodology to Determine VT Contribution to Heavy Truck Fuel Economy Improvement

Heavy Truck MPG Adjustment for GPRA08

EIA Technologies	MPG Increase, %	Market Share, % in 2006	Market Share, % in 2030	Increase in Share	Increase in new MPG from 2006 due to Technology, %	Cumulative MPG Increase-Multiplier	Cumulative MPG Increase, %	Share of Benefit Due to FCVT or Other
Non- FCVT Technologies								
Tires II: Low rolling resistance	3	0	66	66	1.98	1.02	2.0%	
Tires IV: Pneumatic blowing	1.2	0	25	25	0.30	1.023	2.3%	
Weight Reduction	5	0	30	30	1.50	1.038	3.8%	
Transmission related	2	2	100	98	1.96	1.059	5.9%	
Engine V: Friction	2	1	66	65	1.30	1.072	7.2%	
Non-FCVT share of total								53.5%
FCVT Technologies								
Engine VI: Cylinder pressure	4	0	40	40	1.60	1.089	8.9%	
Engine VII: Combustion	6	0	40	40	2.40	1.116	11.6%	
Engine VIII: Waste heat	5	0	35	35	1.75	1.135	13.5%	
Program Share:					5.75			46.5%

Between 2006 and 2030, HT MPG increases 13.5%. Of that increase 53.5%, is from non-FCVT sponsored technologies. Therefore, the base case HT MPG for GPRA08 should have 53.5% of the MPG gain that EIA projects for the Reference Case.

Source: Pesonal Communication, John Maples, EIA and ANL 2001

4.5 VISION 2006 Model

The **VISION** model is used to estimate oil/energy use, and CO_2 emissions from highway vehicles through 2050. (Ref. 18) The model includes Class 3 through 6 and 7 and 8 vehicles—both gasoline and diesel fueled. One can model the potential benefits of various alternative fuel vehicles and enhanced efficiency technologies. The technology market penetration rates calculated in the TRUCK model, based on **vehicle miles,** are used to calculate new vehicle fleet-average fuel economy values (including the effects of new technology for each of the truck classes and types analyzed in TRUCK). The model is used to convert the market penetration results (using the vehicle miles traveled basis) from the TRUCK model into energy and carbon reduction benefits.

A vintaging algorithm accumulates new vehicle sales in the heavy vehicle fleet. The model calculates both baseline and advanced technology vehicle performance and benefits are determined by the differences between the two scenarios. The calculation methodology spans a 50-year analysis period.

For GPRA purposes we also had to adjust the NEMS baseline which is used in VISION to subtract out the effects of DOE supported technologies, specifically for Class 7-8. (We refer to it below as the "adjusted VISION" baseline.)

Exhibit 11: GPRA 08 Heavy Vehicle Benefits Results for NEMS Modeling

Year	Class 7 & 8						Class 3 - 6					
	Combined Market Penetration, % VMT	Base MPG (VISION-Adusted) in gasoline equivalent gallons	Fuel Economy Multiplier only for trucks with new techology which achieve the market penetration shown in Column 2 and Relative to 2005 Truck	Fuel Economy for All New Technology Sales, mpg	Estimate of fuel economy for all new 7-8 trucks	Estimate of X factor to input to VISION (only those for 2010, 2020, 2030, 2040 + 2050 are input)	Combined Market Penetration, % VMT	Base MPG (VISION Adjusted) in gasoline equivalent gallons	Fuel Economy Multiplier only for trucks with new techology which achieve the market penetration shown in Column 10 Relative to 2005 Truck	Fuel Economy for All New Technology Sales, mpg	Estimate of fuel economy for all new 3-6 trucks	Estimate of X factor to input to VISION (only those for 2010, 2020, 2030, 2040 + 2050 are input)
1	2	3	4	5	6	7	8	9	10	11	12	13
2000	0%	6.15	1.00	6.15	6.15	1.00	0%	8.83	1.00	8.59	8.83	1.00
2001	0%	6.15	1.00	6.15	6.15	1.00	0%	8.80	1.00	8.59	8.80	1.00
2002	0%	6.15	1.00	6.15	6.15	1.00	0%	8.77	1.00	8.59	8.77	1.00
2003	0%	6.15	1.00	6.15	6.15	1.00	0%	8.73	1.00	8.59	8.73	1.00
2004	0%	6.15	1.00	6.15	6.15	1.00	0%	8.70	1.00	8.59	8.70	1.00
2005	0%	6.15	1.00	6.15	6.15	1.00	0%	8.59	1.00	8.59	8.59	1.00
2006	0%	6.15	1.06	6.50	6.15	1.00	0%	8.57	1.05	9.00	8.57	1.00
2007	0%	6.15	1.12	6.86	6.15	1.00	0%	8.56	1.10	9.41	8.56	1.00
2008	0%	6.15	1.17	7.22	6.15	1.00	0%	8.56	1.14	9.82	8.56	1.00
2009	0%	6.15	1.23	7.57	6.15	1.00	0%	8.55	1.19	10.23	8.56	1.00
2010	0%	6.15	1.29	7.93	6.148	**1.00**	0%	8.55	1.24	10.65	8.56	**1.00**
2011	0%	6.15	1.31	8.08	6.15	1.00	1%	8.55	1.26	10.79	8.57	1.00
2012	0%	6.15	1.34	8.23	6.15	1.00	1%	8.55	1.28	10.96	8.58	1.00
2013	0%	6.15	1.36	8.39	6.16	1.00	1%	8.56	1.30	11.14	8.58	1.00
2014	1%	6.16	1.39	8.54	6.17	1.00	2%	8.56	1.32	11.31	8.60	1.00
2015	2%	6.17	1.42	8.70	6.20	1.00	3%	8.56	1.34	11.49	8.62	1.01
2016	4%	5.96	1.44	8.85	6.04	1.01	6%	8.57	1.36	11.66	8.71	1.02
2017	9%	6.00	1.47	9.01	6.18	1.03	10%	8.57	1.38	11.84	8.82	1.03
2018	14%	6.03	1.49	9.16	6.32	1.05	17%	8.57	1.40	12.01	9.01	1.05
2019	24%	6.03	1.52	9.32	6.59	1.09	32%	8.57	1.42	12.19	9.46	1.10
2020	43%	6.04	1.54	9.47	7.14	**1.18**	41%	8.57	1.44	12.36	9.82	**1.15**
2021	43%	6.04	1.54	9.47	7.17	1.19	44%	8.62	1.44	12.36	9.95	1.15
2022	51%	6.08	1.54	9.47	7.45	1.23	45%	8.62	1.44	12.36	9.96	1.16
2023	55%	6.09	1.54	9.47	7.56	1.24	45%	8.62	1.44	12.36	9.99	1.16
2024	57%	6.10	1.54	9.47	7.66	1.26	47%	8.62	1.44	12.36	10.06	1.17
2025	63%	6.16	1.54	9.47	7.91	1.28	54%	8.82	1.44	12.36	10.45	1.18
2026	63%	6.16	1.54	9.47	7.92	1.29	56%	8.82	1.44	12.36	10.49	1.19
2027	64%	6.16	1.54	9.47	7.92	1.29	56%	8.82	1.44	12.36	10.49	1.19
2028	63%	6.16	1.54	9.47	7.92	1.29	56%	8.82	1.44	12.36	10.49	1.19
2029	64%	6.16	1.54	9.47	7.92	1.29	57%	8.82	1.44	12.36	10.55	1.20
2030	64%	6.17	1.54	9.47	7.93	**1.29**	59%	8.82	1.44	12.36	10.61	**1.20**
2031	64%	6.18	1.54	9.47	7.94	1.28	61%	8.85	1.44	12.36	10.72	1.21
2032	64%	6.20	1.54	9.47	7.95	1.28	66%	8.87	1.44	12.36	10.89	1.23
2033	64%	6.21	1.54	9.47	7.96	1.28	66%	8.90	1.44	12.36	10.91	1.23
2034	64%	6.22	1.54	9.47	7.98	1.28	66%	8.93	1.44	12.36	10.92	1.22
2035	64%	6.24	1.54	9.47	7.99	1.28	66%	8.95	1.44	12.36	10.94	1.22
2036	64%	6.25	1.54	9.47	8.01	1.28	66%	8.98	1.44	12.36	10.95	1.22
2037	65%	6.27	1.54	9.47	8.03	1.28	66%	9.01	1.44	12.36	10.97	1.22
2038	65%	6.28	1.54	9.47	8.04	1.28	66%	9.03	1.44	12.36	10.98	1.22
2039	65%	6.29	1.54	9.47	8.06	1.28	66%	9.06	1.44	12.36	11.00	1.21
2040	65%	6.31	1.54	9.47	8.07	**1.28**	66%	9.09	1.44	12.36	11.01	**1.21**
2041	65%	6.32	1.54	9.47	8.08	1.28	66%	9.12	1.44	12.36	11.03	1.21
2042	65%	6.34	1.54	9.47	8.09	1.28	66%	9.14	1.44	12.36	11.04	1.21
2043	65%	6.35	1.54	9.47	8.10	1.28	66%	9.17	1.44	12.36	11.06	1.21
2044	66%	6.37	1.54	9.47	8.11	1.27	66%	9.20	1.44	12.36	11.07	1.20
2045	66%	6.38	1.54	9.47	8.12	1.27	66%	9.23	1.44	12.36	11.09	1.20
2046	66%	6.40	1.54	9.47	8.13	1.27	66%	9.26	1.44	12.36	11.11	1.20
2047	66%	6.41	1.54	9.47	8.14	1.27	66%	9.28	1.44	12.36	11.13	1.20
2048	66%	6.43	1.54	9.47	8.16	1.27	67%	9.31	1.44	12.36	11.14	1.20
2049	66%	6.44	1.54	9.47	8.17	1.27	67%	9.34	1.44	12.36	11.16	1.20
2050	66%	6.45	1.54	9.47	8.18	**1.27**	67%	9.37	1.44	12.36	11.19	**1.19**

For Class 7 and 8 vehicles, the market penetration of new technology trucks for each year is linked to the Truck 2.30 Model results and is shown in Column 2. The adjusted VISION baseline fuel economy factors are shown in Column 3. The fuel economy multipliers in Column 4 are those of the two-year and newer vehicles with energy conserving technology as calculated by the Truck model. These multipliers are relative to the year 2005 baseline truck in TRUCK. Column 5 shows the actual fuel economy of the new technology vehicles; they are the result of the multiplication of the multipliers times the year 2005 baseline truck in VISION (6.15). The average fuel economy of all new trucks including those with and without new technology is indicated in Column 6. The ratio or "X" factor used in VISION is shown in Column 7 and it is the ratio of Column 6 to Column 3.

The adjustments between the TRUCK model results and VISION for Class 3 through 6 vehicles is analogous to what is described above and also are shown in Exhibit 10, Column 13.

4.6 Heavy Truck Summary

The **Heavy Truck Summary** report generator summarizes the first order benefits for the period covering 2000 through 2050 at the program element level. Benefits are reported as follows:

- Heavy Vehicle Technology GPRA 06 Inputs
- Heavy Truck Petroleum Use
- Oil Benefits by Program Type
- Energy Carbon & Stock
- Benefits Contribution Worksheet—by program element.

These outputs were presented in the Executive Summary and in Section 5.

4.7 List of Key Assumptions

A list of key assumptions is contained in Exhibit 12. Additional assumptions can be seen by reviewing Appendix A—especially Inputs, Fuel Prices, and Market Data pages, and by reviewing Reference 18.

Exhibit 12: List of Key Assumptions

Item	Value	Comments
Combination Unit Vehicles		
Vehicle Miles	21,046,765,000	VIUS 2002 & TRUCK 3.0
Enhanced Fuel Economy, MPG	9.5	From HTEB Model
Baseline Fuel Economy, MPG	6.1	VIUS 2002
Gallons (Baseline)	3,444,642,390	
Drag Coefficient Improvement, %	7.5%	
Engine Efficiency Improvement, %	37	
Engine Peak Output, kW	250	
Engine Average Output, kW	109	Enhanced vehicles
Single Unit Vehicles		
Vehicle Miles	2,395,735,000	VIUS 2002 & TRUCK 3.0
Enhanced Fuel Economy, MPG	10.0	From HTEB Model
Baseline Fuel Economy, MPG	6.7	VIUS 2002
Gallons (Baseline)	359,180,660	
Drag Coefficient Improvement, %	15.0%	
Engine Efficiency Improvement, %	34.0%	
Engine Peak Output, kW	150	
Engine Average Output, kW	34	Enhanced vehicles
Total Fleet-Class 7&8 Vehicles		
Total Vehicle Miles	23,442,500,000	VIUS < 2 yr. old vehicles
Total Gallons	3,803,823,049	
Fuel Economy MPG	6.2	
Total Vehicles	294,559	VIUS < 2 yr. old vehicles
Average Gallons	12,914	
Two Year Consumption:	25,827	
Diesel Fuel Price (2006) $/Gal.	2.38	AEO 2005
Fuel Economy Improvement:	50%	
Percent Fuel Savings	33.3%	
Value of Savings-2 yr payback, $	20,469	Used to Determine Technology Cost
Type M Vehicles (Diesel + Gasoline)		
Total Vehicle Miles	5,928,045,000	VIUS < 2 yr. old vehicles
Gallons	659,174,520	
Baseline Fuel Economy, MPG	8.99	
Total Vehicles (Diesel + Gasoline)	287,553	
Fuel Economy with Improvements, MPG	12.5	
Drag Coefficient Improvement, %	15.0%	
Engine Efficiency Improvement, %	37.5%	
Engine Peak Output, kW	100	
Engine Average Output, kW	20	
Gallons/veh	2,292	
Two Year Consumption	4,585	
Fuel Economy Improvement:	40%	
Value of Savings-2 yr payback, $	3,050	Used to determine technology cost

5.0 Results

Selected results from the Heavy Truck summary report are presented in the following pages. The market penetrations and savings are based on vehicle miles traveled.

Exhibit 13: Heavy Vehicle Technologies GPRA 08 Results

	Characteristic	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050	Notes
1	Oil Use Class 7- 8-Combination Unit Trucks, mmbpd	1.682	1.908	2.104	2.303	2.502	2.833	2.974	3.174	3.339	3.498	
2	Oil Use Class 7- 8-Single Unit Trucks, mmbpd	0.299	0.348	0.381	0.417	0.439	0.466	0.474	0.489	0.503	0.518	
3	Oil Use Class 7- 8-Hybrid Trucks, mmbpd	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
4	Oil Use Total, Class 7-8, mmbpd	1.982	2.256	2.485	2.719	2.941	3.298	3.448	3.663	3.842	4.017	
5	Oil Use Class 3-6 Diesel, mmbpd	0.252	0.279	0.316	0.361	0.412	0.469	0.493	0.518	0.540	0.565	
6	Oil use Class 3-6 Gasoline, mmbpd	0.105	0.101	0.107	0.117	0.130	0.147	0.155	0.161	0.166	0.171	
7	Oil Use Total Class 3-6, mmbpd	0.357	0.380	0.423	0.477	0.543	0.615	0.648	0.679	0.706	0.736	
8	Total Oil Use, mmbpd	2.339	2.636	2.908	3.196	3.483	3.914	4.096	4.342	4.548	4.752	
9	Class 7- 8-Combination Unit Reduction, mmbpd	0	0.000	0.000	0.095	0.267	0.448	0.569	0.658	0.715	0.748	
10	Class 7- 8-Single Unit Reduction, mmbpd	0	0.000	0.000	0.012	0.035	0.060	0.079	0.094	0.106	0.111	
11	Class 7- 8-Hybrid (Type 3) Reduction, mmbpd	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
12	Class 7-8 Oil Reduction, Total mmbpd	0.000	0.000	0.000	0.107	0.302	0.508	0.648	0.752	0.821	0.859	
13	Oil Reduction Class 3-6 Diesel, mmbpd	0	0.000	0.001	0.011	0.022	0.030	0.037	0.043	0.047	0.049	
14	Oil Reduction Class 3-6 Gasoline, mmbpd	0	0.000	0.000	0.004	0.012	0.019	0.024	0.027	0.028	0.029	
15	Class 3-6 Oil Reduction, Total mmbpd	0.000	0.000	0.001	0.015	0.034	0.050	0.061	0.070	0.075	0.077	
16	Total Oil Reduction, mmbpd	0.000	0.000	0.001	0.122	0.336	0.557	0.709	0.822	0.896	0.936	
17	Oil Reduction Class 7-8, %	0%	0%	0%	4%	10%	15%	19%	21%	21%	21%	
18	Oil Reduction Class 3-6, %	0%	0%	0%	3%	6%	8%	9%	10%	11%	10%	
19	Total Oil Reduction, %	0%	0%	0%	4%	10%	14%	17%	19%	20%	20%	
20	Total Carbon Emissions, mmtce	133.85	150.87	166.44	182.94	199.36	223.99	234.43	248.51	260.31	272.00	
21	Carbon Reduction Class 7- 8-Combination(Type 1), mmtce	0.0	0.0	0.0	5.4	15.3	25.7	32.6	37.7	41.0	42.9	
22	Carbon Reduction Class 7- 8-Single Unit (Type 2), mmtce	0.0	0.0	0.0	0.7	2.0	3.4	4.5	5.4	6.0	6.3	
23	Carbon Reduction Class 7- 8-Hybrid (Type 3), mmtce	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
24	Total Carbon Reduction Class 7-8, mmtce	0.0	0.0	0.0	6.1	17.3	29.1	37.1	43.1	47.0	49.2	
25	Carbon Reduction Class 3-6 Diesel, mmtce	0.0	0.0	0.0	0.6	1.3	1.7	2.1	2.5	2.7	2.8	
26	Carbon Reduction Class 3-6 Gasoline, mmtce	0.0	0.0	0.0	0.2	0.7	1.1	1.3	1.5	1.6	1.6	
27	Total Carbon Reduction Class 3-6, mmtce	0	0	0	1	2	3	3	4	4	4	
28	Total Carbon Reduction, mmtce	0.0	0.0	0.0	7.0	19.2	31.9	40.6	47.1	51.3	53.6	
29	Total Carbon Reduction, %	0%	0%	0%	4%	10%	14%	17%	19%	20%	20%	
30	Vehicle Miles Traveled Class 7-8, Combination; millions	149,899	171,849	192,962	217,088	243,882	276,584	292,883	317,381	340,368	363,879	
31	Vehicle Miles Traveled Class 7-8, Single Unit; mllions	29,848	35,105	38,932	42,494	44,595	47,022	47,984	49,508	51,225	53,279	
32	Vehicle Miles Traveled Class 7-8, Hybrid; millions	0	0	0	0	0	0	0	0	0	0	
33	Total Class 7-8, billions	180	207	232	260	288	324	341	367	392	417	
34	Vehicle Miles Traveled Class 3-6, Diesel, milliions	34,894	39,266	44,766	51,296	59,018	67,775	75,848	82,625	86,939	87,745	
35	Vehicle Miles Traveled Class 3-6, Gasoline, millions	15,101	14,617	15,676	17,230	19,270	21,642	23,895	25,815	27,050	27,255	
36	Total Class 3-6 , billions	50	54	60	69	78	89	100	108	114	115	
37	Total Vehicle Miles Traveled , millions	230	261	292	328	367	413	441	475	506	532	
38	Fuel Economy Class 7-8, Combination, mpg	6.09	6.09	6.11	7.28	8.02	8.03	8.05	8.09	8.11	8.13	
39	Fuel Economy Class 7-8, Single Unit, mpg	6.69	6.69	6.72	6.96	7.22	7.24	7.24	7.25	7.26	7.27	
40	Fuel Economy Class 7-8, Hybrid, mpg	6.69	6.69	6.69	6.69	6.69	6.69	6.69	6.69	6.69	6.69	
41	Average, Class 7-8, mpg	6.15	6.15	6.17	7.24	7.93	7.94	7.96	8.00	8.01	8.03	
42	Fuel Economy Class 3-6, Diesel, mpg	9.31	9.31	9.34	10.33	10.86	11.37	11.83	11.84	11.85	11.89	
43	Fuel Economy Class 3-6, Gasoline, mpg	8.83	8.83	8.84	9.31	10.39	10.39	10.39	10.39	10.40	10.40	
44	Average, Class 3-6, mpg	9.21	9.22	9.26	10.55	11.05	11.23	11.52	11.53	11.54	11.58	
45	Market Penetration Class 7-8, Combination, % VMT	0.0%	0.1%	1.6%	46.2%	68.0%	68.3%	68.9%	70.1%	70.4%	71.1%	
46	Market Penetration Class 7-8, Single Unit, % VMT	0.0%	0.1%	1.8%	11.5%	22.0%	22.8%	23.0%	23.3%	23.6%	23.9%	
47	Market Penetration Class 7-8, Hybrid, % VMT	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
48	Market Penetration--All Types, Class 7-8, % VMT	0.0%	0.1%	1.6%	42.6%	63.3%	63.7%	64.2%	65.3%	65.7%	66.2%	
49	Market Penetration Class 3-6 Gasoline, % VMT	0.0%	0.0%	2.5%	37.1%	48.6%	48.7%	48.7%	48.7%	48.8%	49.0%	
50	Market Penetration Class 3-6 Diesel, % VMT	0.0%	0.6%	2.8%	42.5%	55.9%	61.4%	69.9%	70.1%	70.5%	71.5%	
51	Market Penetration All types Class 3-6 , % VMT	0.0%	0.5%	2.7%	41.5%	54.5%	58.9%	65.8%	66.0%	66.2%	67.1%	
52	Vehicle Stock Class 7-8, Combination, vehicles x 1000	4	4	4	5	5	5	5	6	6	6	
53	Vehicle Stock Class 7-8, Single Unit, Vehicles x 1000	1	2	2	2	2	2	2	2	2	2	
54	Vehicle Stock Class 7-8, Hybrid, Vehicles x 1000	0	0	0	0	0	0	0	0	0	0	
55	Total Vehicle Stock Class 7-8, Vehicles X 1000000	4.94	5.58	6.04	6.45	6.73	7.02	7.31	7.63	8.02	8.50	
56	Vehicle Stock Class 3-6, Diesel, x 1000	2.80	2.96	3.07	3.22	3.38	3.56	3.68	3.82	3.97	4.12	
57	Vehicle Stock Class 3-6, Gasoline, x 1000	1.45	1.53	1.59	1.67	1.75	1.84	1.91	1.98	2.06	2.13	
58	Total Vehicle Stock Class 3-6, Vehicles X 1000000	4.25	4.49	4.67	4.89	5.13	5.40	5.58	5.80	6.03	6.25	
59	Total Vehicle Stock, Vehicles X 1000000	9.18	10.07	10.70	11.34	11.85	12.43	12.89	13.43	14.05	14.75	

Exhibit 14: Heavy Vehicle Technologies GPRA 0 Results by Program Element

	Characteristic	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
	Consumption Breakdown, mmbpd										
1	Oil Use Class 7- 8-Combination Unit Trucks, mmbpd	1.682	1.908	2.104	2.303	2.502	2.833	2.974	3.174	3.339	3.498
2	Oil Use Class 7- 8-Single Unit Trucks, mmbpd	0.299	0.348	0.381	0.417	0.439	0.466	0.474	0.489	0.503	0.518
3	Oil Use Class 7- 8-Hybrid Trucks, mmbpd	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	Oil Use Total, Class 7-8, mmbpd	1.982	2.256	2.485	2.719	2.941	3.298	3.448	3.663	3.842	4.017
5	Oil Use Class 3-6 Diesel, mmbpd	0.252	0.279	0.316	0.361	0.412	0.469	0.493	0.518	0.540	0.565
6	Oil use Class 3-6 Gasoline, mmbpd	0.105	0.101	0.107	0.117	0.130	0.147	0.155	0.161	0.166	0.171
7	Oil Use Class 3-6	0.357	0.380	0.423	0.477	0.543	0.615	0.648	0.679	0.706	0.736
8	Total Oil Use, mmbpd	2.339	2.636	2.908	3.196	3.483	3.914	4.096	4.342	4.548	4.752
9	Class 7 & 8 Savings Breakdown, mmbpd										
10	Oil Reduction Class 7- 8-Auxiliary Load Reduction	0	0.000	0.000	0.003	0.008	0.013	0.017	0.020	0.022	0.023
11	Idle Hour Reduction	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	Oil Reduction Class 7- 8--Engine Efficiency/WHR	0	0.000	0.000	0.092	0.261	0.438	0.560	0.649	0.709	0.742
13	Oil Reduction Class 7- 8--Vehicle Weight Reduction	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14	Oil Reduction Class 7- 8-Aerodynamic Load Reduction	0	0.000	0.000	0.012	0.033	0.056	0.066	0.083	0.091	0.095
15	Class 7-8 Oil Reduction, Total mmbpd	0.000	0.000	0.000	0.107	0.302	0.508	0.648	0.752	0.821	0.859
16	Oil Reduction Class 3-6-Auxiliary Load Reduction	0	0.0000	0.000	0.001	0.002	0.003	0.004	0.004	0.005	0.005
17	Oil Reduction Class 3-6--Engine Efficiency/WHR	0	0.0000	0.001	0.014	0.031	0.045	0.056	0.064	0.069	0.071
18	Oil Reduction Class 3-6--Vehicle Weight Reduction	0	0.0000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
19	Oil Reduction Class 3-6-Aerodynamic Load Reduction	0	0.0000	0.000	0.000	0.001	0.001	0.001	0.001	0.002	0.002
20	Oil Reduction Class 3-6-Hybrid	0	0.0000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
21	Oil Reduction Class 3-6, mmbpd	0.000	0.000	0.001	0.015	0.034	0.050	0.061	0.070	0.075	0.077
22	Total Oil Reduction, mmbpd	0.000	0.000	0.001	0.122	0.336	0.557	0.709	0.822	0.896	0.936
27	Oil Reduction-Auxiliary Load Reduction	0.0%	0.0%	0.0%	0.1%	0.3%	0.4%	0.5%	0.6%	0.6%	0.6%
28	Idle Hour Reduction	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
29	Oil Reduction--Engine Efficiency/WHR	0.0%	0.0%	0.0%	3.3%	8.4%	12.4%	15.0%	16.4%	17.1%	17.1%
30	Oil Reduction--Vehicle Weight Reduction	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
31	Oil Reduction-Aerodynamic Load Reduction	0.0%	0.0%	0.0%	0.4%	1.0%	1.5%	1.6%	1.9%	2.0%	2.0%
32	Oil Reduction-Hybrid	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
33	Total Oil Reduction, %	0%	0%	0%	4%	10%	14%	17%	19%	20%	20%
34	Total Carbon Emissions, Diesel	72.929	143.79	158.73	174.46	189.90	213.43	223.34	236.91	248.30	259.55
35	Total Carbon Emissions, Gas	7.022	7.080	7.703	8.483	9.457	10.561	11.095	11.595	12.009	12.447
36	Total Carbon Emissions, mmtce	133.85	150.87	166.44	182.94	199.36	223.99	234.43	248.51	260.31	272.00
37	Carbon Emissions-Auxiliary Load Reduction, mmtce	-	-	0.00	0.18	0.51	0.84	1.07	1.24	1.35	1.41
38	Carbon Reduction--Engine Efficiency/WHR, mmtce	-	-	0.04	6.01	16.59	27.52	35.04	40.63	44.28	46.26
39	Carbon Reduction--Vehicle Weight Reduction, mmtce	-	-	-	-	-	-	-	-	-	-
40	Carbonl Reduction-Aerodynamic Load Red., mmtce	-	-	0.00	0.77	2.12	3.52	4.48	5.19	5.66	5.91
41	Carbon Reduction-Hybrid, mmtce	-	-	-	-	-	-	-	-	-	-
42	Total Carbon Reduction, mmtce	0.0	0.0	0.0	7.0	19.2	31.9	40.6	47.1	51.3	53.6
43	Total Carbon Reduction, %	0%	0%	0%	4%	10%	14%	17%	19%	20%	20%

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Appendix A

TRUCK 3.0 Model

Inputs

CLASS 7 & 8 Combination Units

Year	Baseline Vehicle Cost ($)	*Non-Hybrid Technologies*			
		Diesel Fuel (only)			
		Gross 1st Cost ($)	Subsidy = 0%	Net Cost ($)	Efficiency Ratio
2000	150,000	0	0	0	1.000
2001	150,000	0	0	0	1.000
2002	150,000	0	0	0	1.000
2003	150,000	0	0	0	1.000
2004	150,000	45,000	0	45,000	1.000
2005	150,000	45,000	0	45,000	1.100
2006	150,000	42,000	0	42,000	1.138
2007	150,000	39,000	0	39,000	1.176
2008	150,000	36,000	0	36,000	1.214
2009	150,000	33,000	0	33,000	1.251
2010	150,000	30,000	0	30,000	1.289
2011	150,000	28,000	0	28,000	1.289
2012	150,000	26,000	0	26,000	1.289
2013	150,000	24,000	0	24,000	1.289
2014	150,000	22,000	0	22,000	1.289
2015	150,000	20,000	0	20,000	1.289
2016	150,000	19,000	0	19,000	1.341
2017	150,000	18,000	0	18,000	1.392
2018	150,000	17,000	0	17,000	1.443
2019	150,000	16,000	0	16,000	1.495
2020	150,000	15,000	0	15,000	1.546
2021	150,000	14,000	0	14,000	1.546
2022	150,000	13,000	0	13,000	1.546
2023	150,000	12,000	0	12,000	1.546
2024	150,000	11,000	0	11,000	1.546
2025	150,000	10,000	0	10,000	1.546
2026	150,000	10,000	0	10,000	1.546
2027	150,000	10,000	0	10,000	1.546
2028	150,000	10,000	0	10,000	1.546
2029	150,000	10,000	0	10,000	1.546
2030	150,000	10,000	0	10,000	1.546
2031	150,000	10,000	0	10,000	1.546
2032	150,000	10,000	0	10,000	1.546
2033	150,000	10,000	0	10,000	1.546
2034	150,000	10,000	0	10,000	1.546
2035	150,000	10,000	0	10,000	1.546
2036	150,000	10,000	0	10,000	1.546
2037	150,000	10,000	0	10,000	1.546
2038	150,000	10,000	0	10,000	1.546
2039	150,000	10,000	0	10,000	1.546
2040	150,000	10,000	0	10,000	1.546
2041	150,000	10,000	0	10,000	1.546
2042	150,000	10,000	0	10,000	1.546
2043	150,000	10,000	0	10,000	1.546
2044	150,000	10,000	0	10,000	1.546
2045	150,000	10,000	0	10,000	1.546
2046	150,000	10,000	0	10,000	1.546
2047	150,000	10,000	0	10,000	1.546
2048	150,000	10,000	0	10,000	1.546
2049	150,000	10,000	0	10,000	1.546
2050	150,000	10,000	0	10,000	1.546

Fuel Prices

Transportation Energy Prices
AEO'05 ***Last Update: 6/21/06*** by: Grant Miller/ Gas and Diesel Only
AEO Input Values in Yellow Boxes
Old Values from previous AEO Reports in Grey Boxes Extrapolated Values are in Blue Font
Reference values are highlighted. All others are by linear interpolation

	2003 Dollars per Million BTU						2003 Dollars Per Gallon-Gasoline Equivalent (except Diesel Fuel which is in $/gal of diesel fuel)					
Year	Gasoline	Diesel	LPG	CNG	Electricity	Ethanol	Gasoline	Diesel	LPG	CNG	Electricity	Ethanol
1995												
1996												
1997												
1998												
1999												
2000	12.42	10.99	16.45	6.76	22.07	17.72	1.55	1.52	2.06	0.85	2.76	2.22
2001	11.99	10.16	17.12	8.69	21.58	16.56	1.50	1.41	2.14	1.09	2.70	2.07
2002	11.32	9.55	15.15	7.23	20.03	14.65	1.42	1.33	1.89	0.90	2.50	1.83
2003	13.31	11.24	16.65	9.04	20.64	16.23	1.66	1.56	2.08	1.13	2.58	2.03
2004	15.34	13.25	20.60	9.71	21.20	19.66	1.92	1.84	2.58	1.21	2.65	2.46
2005	18.60	16.99	20.42	9.80	20.92	19.59	2.33	2.36	2.55	1.22	2.62	2.45
2006	18.85	17.16	16.38	9.30	19.97	19.47	2.36	2.38	2.05	1.16	2.50	2.43
2007	18.16	15.33	15.82	8.98	19.09	18.31	2.27	2.13	1.98	1.12	2.39	2.29
2008	17.83	15.07	15.60	8.72	18.80	18.15	2.23	2.09	1.95	1.09	2.35	2.27
2009	17.22	14.63	15.31	8.63	18.83	17.74	2.15	2.03	1.91	1.08	2.35	2.22
2010	16.52	14.29	15.24	8.56	18.81	17.11	2.06	1.98	1.91	1.07	2.35	2.14
2011	16.56	14.53	15.18	8.62	18.83	16.99	2.07	2.02	1.90	1.08	2.35	2.12
2012	16.47	14.43	15.20	8.71	19.02	16.89	2.06	2.00	1.90	1.09	2.38	2.11
2013	16.39	14.53	15.25	8.83	19.23	17.11	2.05	2.02	1.91	1.10	2.40	2.14
2014	16.27	14.37	15.18	8.99	19.52	17.30	2.03	1.99	1.90	1.12	2.44	2.16
2015	16.34	14.56	15.28	9.11	19.59	17.37	2.04	2.02	1.91	1.14	2.45	2.17
2016	16.46	14.53	15.38	9.10	19.54	17.40	2.06	2.02	1.92	1.14	2.44	2.18
2017	16.55	14.51	15.37	9.10	19.58	17.43	2.07	2.01	1.92	1.14	2.45	2.18
2018	16.67	14.67	15.39	9.20	19.71	17.50	2.08	2.04	1.92	1.15	2.46	2.19
2019	16.80	14.66	15.51	9.34	19.90	17.11	2.10	2.03	1.94	1.17	2.49	2.14
2020	17.02	14.78	15.66	9.45	19.99	17.22	2.13	2.05	1.96	1.18	2.50	2.15
2021	17.14	14.83	15.77	9.54	20.05	17.67	2.14	2.06	1.97	1.19	2.51	2.21
2022	17.25	14.84	15.85	9.58	19.98	17.68	2.16	2.06	1.98	1.20	2.50	2.21
2023	17.34	15.02	16.04	9.58	19.89	17.87	2.17	2.08	2.00	1.20	2.49	2.23
2024	17.41	15.09	16.11	9.64	19.92	17.99	2.18	2.09	2.01	1.21	2.49	2.25
2025	17.49	15.15	16.24	9.69	19.96	18.13	2.19	2.10	2.03	1.21	2.49	2.27
2026	17.58	15.35	16.36	9.74	19.95	18.32	2.20	2.13	2.05	1.22	2.49	2.29
2027	17.64	15.46	16.49	9.79	19.95	18.50	2.20	2.14	2.06	1.22	2.49	2.31
2028	17.74	15.65	16.61	9.85	19.94	18.70	2.22	2.17	2.08	1.23	2.49	2.34
2029	17.82	15.44	16.73	9.90	19.94	18.89	2.23	2.14	2.09	1.24	2.49	2.36
2030	17.92	15.65	16.85	9.95	19.93	19.08	2.24	2.17	2.11	1.24	2.49	2.39
2031	18.02	15.73	16.98	10.00	19.92	19.28	2.25	2.18	2.12	1.25	2.49	2.41
2032	18.11	15.80	17.10	10.05	19.92	19.48	2.26	2.19	2.14	1.26	2.49	2.43
2033	18.21	15.88	17.23	10.10	19.91	19.68	2.28	2.20	2.15	1.26	2.49	2.46
2034	18.31	15.96	17.35	10.16	19.91	19.88	2.29	2.21	2.17	1.27	2.49	2.49
2035	18.41	16.04	17.48	10.21	19.90	20.09	2.30	2.22	2.19	1.28	2.49	2.51
2036	18.51	16.12	17.61	10.26	19.90	20.30	2.31	2.24	2.20	1.28	2.49	2.54
2037	18.61	16.20	17.74	10.32	19.89	20.51	2.33	2.25	2.22	1.29	2.49	2.56
2038	18.72	16.28	17.87	10.37	19.88	20.72	2.34	2.26	2.23	1.30	2.49	2.59
2039	18.82	16.36	18.00	10.42	19.88	20.93	2.35	2.27	2.25	1.30	2.48	2.62
2040	18.92	16.45	18.14	10.48	19.87	21.15	2.37	2.28	2.27	1.31	2.48	2.64
2041	19.02	16.53	18.27	10.53	19.87	21.37	2.38	2.29	2.28	1.32	2.48	2.67
2042	19.13	16.61	18.40	10.59	19.86	21.59	2.39	2.30	2.30	1.32	2.48	2.70
2043	19.23	16.69	18.54	10.64	19.85	21.81	2.40	2.32	2.32	1.33	2.48	2.73
2044	19.34	16.78	18.68	10.70	19.85	22.03	2.42	2.33	2.33	1.34	2.48	2.75
2045	19.44	16.86	18.81	10.75	19.84	22.26	2.43	2.34	2.35	1.34	2.48	2.78
2046	19.55	16.94	18.95	10.81	19.84	22.49	2.44	2.35	2.37	1.35	2.48	2.81
2047	19.66	17.03	19.09	10.86	19.83	22.72	2.46	2.36	2.39	1.36	2.48	2.84
2048	19.76	17.11	19.23	10.92	19.83	22.96	2.47	2.37	2.40	1.36	2.48	2.87
2049	19.87	17.20	19.37	10.98	19.82	23.19	2.48	2.39	2.42	1.37	2.48	2.90
2050	19.98	17.28	19.52	11.03	19.81	23.43	2.50	2.40	2.44	1.38	2.48	2.93

Market Data

Class 7 & 8 Vehicle Distribution by Annual VMT and Tractor-Trailers
Vehicle Age 2 or Less
Ref: 2002 VIUS

	Vehicles				Percent			
VMT (1000)	Central	Central Veh-Miles	Non-Central	Non-Central Veh-Miles	Central	Central Veh-Miles	Non-Central	Non-Central Veh-Miles
0	0	0	0	0	0.00%	0.00%	0.00%	0.00%
5	455	2275	559	2795	0.21%	0.01%	0.26%	0.01%
10	737	7370	1054	10540	0.35%	0.04%	0.49%	0.05%
15	1503	22545	2521	37815	0.71%	0.11%	1.18%	0.18%
20	1631	32620	2144	42880	0.77%	0.15%	1.01%	0.20%
25	2288	57200	2809	70225	1.07%	0.27%	1.32%	0.33%
30	1674	50220	2819	84570	0.79%	0.24%	1.32%	0.40%
35	1874	65590	2203	77105	0.88%	0.31%	1.03%	0.37%
40	1720	68800	1966	78640	0.81%	0.33%	0.92%	0.37%
45	1780	80100	846	38070	0.84%	0.38%	0.40%	0.18%
50	2647	132350	2200	110000	1.24%	0.63%	1.03%	0.52%
55	1817	99935	2562	140910	0.85%	0.47%	1.20%	0.67%
60	2252	135120	2788	167280	1.06%	0.64%	1.31%	0.79%
65	2406	156390	2512	163280	1.13%	0.74%	1.18%	0.78%
70	2243	157010	2751	192570	1.05%	0.75%	1.29%	0.91%
75	3776	283200	3912	293400	1.77%	1.35%	1.84%	1.39%
80	3404	272320	4356	348480	1.60%	1.29%	2.05%	1.66%
85	3964	336940	5453	463505	1.86%	1.60%	2.56%	2.20%
90	3170	285300	2829	254610	1.49%	1.36%	1.33%	1.21%
95	3417	324615	4599	436905	1.60%	1.54%	2.16%	2.08%
100	3503	350300	7283	728300	1.64%	1.66%	3.42%	3.46%
105	2576	270480	4187	439635	1.21%	1.29%	1.97%	2.09%
110	1259	138490	7806	858660	0.59%	0.66%	3.67%	4.08%
115	1930	221950	6444	741060	0.91%	1.05%	3.03%	3.52%
120	1799	215880	10050	1206000	0.84%	1.03%	4.72%	5.73%
125	7315	914375	13707	1713375	3.43%	4.34%	6.44%	8.14%
130	2099	272870	7045	915850	0.99%	1.30%	3.31%	4.35%
135	2227	300645	6752	911520	1.05%	1.43%	3.17%	4.33%
140	1785	249900	4119	576660	0.84%	1.19%	1.93%	2.74%
145	1583	229535	3546	514170	0.74%	1.09%	1.67%	2.44%
150	2559	383850	3543	531450	1.20%	1.82%	1.66%	2.53%
155	1568	243040	1595	247225	0.74%	1.15%	0.75%	1.17%
160	888	142080	2042	326720	0.42%	0.68%	0.96%	1.55%
165	693	114345	1196	197340	0.33%	0.54%	0.56%	0.94%
170	772	131240	848	144160	0.36%	0.62%	0.40%	0.68%
175	624	109200	676	118300	0.29%	0.52%	0.32%	0.56%
180	663	119340	492	88560	0.31%	0.57%	0.23%	0.42%
185	196	36260	954	176490	0.09%	0.17%	0.45%	0.84%
190	307	58330	907	172330	0.14%	0.28%	0.43%	0.82%
195	419	81705	507	98865	0.20%	0.39%	0.24%	0.47%
200	153	30600	711	142200	0.07%	0.15%	0.33%	0.68%
212.5	0	0	0	0	0.00%	0.00%	0.00%	0.00%
Total	77676	7184315	135293	13862450	36.5%	34.1%	63.5%	65.9%

Market Data (Continued)

Class 7 & 8 Vehicle Distribution by Annual VMT and Single Unit (normal diesel and gas)
Vehicle Age 2 or Less
Ref: 2002 VIUS

	Vehicles				Percent			
VMT (1000)	Central	Central Veh-Miles	Non-Central	Non-Central Veh-Miles	Central	Central Veh-Miles	Non-Centra	Non-Central
0	0	0	0	0	0.00%	0.00%	0.00%	0.00%
5	2101	10505	3472	17360	2.58%	0.44%	4.26%	0.72%
10	6486	64860	5541	55410	7.95%	2.71%	6.79%	2.31%
15	5456	81840	4042	60630	6.69%	3.42%	4.95%	2.53%
20	4867	97340	5266	105320	5.97%	4.06%	6.45%	4.40%
25	4390	109750	4666	116650	5.38%	4.58%	5.72%	4.87%
30	4757	142710	4652	139560	5.83%	5.96%	5.70%	5.83%
35	2926	102410	4570	159950	3.59%	4.27%	5.60%	6.68%
40	2064	82560	1795	71800	2.53%	3.45%	2.20%	3.00%
45	1675	75375	1512	68040	2.05%	3.15%	1.85%	2.84%
50	1427	71350	864	43200	1.75%	2.98%	1.06%	1.80%
55	683	37565	862	47410	0.84%	1.57%	1.06%	1.98%
60	386	23160	480	28800	0.47%	0.97%	0.59%	1.20%
65	580	37700	231	15015	0.71%	1.57%	0.28%	0.63%
70	337	23590	1078	75460	0.41%	0.98%	1.32%	3.15%
75	932	69900	241	18075	1.14%	2.92%	0.30%	0.75%
80	154	12320	671	53680	0.19%	0.51%	0.82%	2.24%
85	29	2465	73	6205	0.04%	0.10%	0.09%	0.26%
90	334	30060	190	17100	0.41%	1.25%	0.23%	0.71%
95	53	5035	60	5700	0.06%	0.21%	0.07%	0.24%
100	284	28400	175	17500	0.35%	1.19%	0.21%	0.73%
105	200	21000	167	17535	0.25%	0.88%	0.20%	0.73%
110	0	0	29	3190	0.00%	0.00%	0.04%	0.13%
115	0	0	0	0	0.00%	0.00%	0.00%	0.00%
120	0	0	0	0	0.00%	0.00%	0.00%	0.00%
125	0	0	0	0	0.00%	0.00%	0.00%	0.00%
130	0	0	209	27170	0.00%	0.00%	0.26%	1.13%
135	0	0	53	7155	0.00%	0.00%	0.06%	0.30%
140	156	21840	46	6440	0.19%	0.91%	0.06%	0.27%
145	0	0	10	1450	0.00%	0.00%	0.01%	0.06%
150	0	0	0	0	0.00%	0.00%	0.00%	0.00%
155	0	0	281	43555	0.00%	0.00%	0.34%	1.82%
160	0	0	0	0	0.00%	0.00%	0.00%	0.00%
165	0	0	0	0	0.00%	0.00%	0.00%	0.00%
170	0	0	0	0	0.00%	0.00%	0.00%	0.00%
175	0	0	0	0	0.00%	0.00%	0.00%	0.00%
180	0	0	38	6840	0.00%	0.00%	0.05%	0.29%
185	0	0	0	0	0.00%	0.00%	0.00%	0.00%
190	0	0	0	0	0.00%	0.00%	0.00%	0.00%
195	0	0	0	0	0.00%	0.00%	0.00%	0.00%
200	39	7800	0	0	0.05%	0.33%	0.00%	0.00%
212.5	0	0	0	0	0.00%	0.00%	0.00%	0.00%
Total	40316	1159535	41274	1236200	49.4%	48.4%	50.6%	51.6%

Class 7&8 Vehicle Distribution by Annual VMT and Primary Refueling
Vehicle Age 2 or Less
Ref: 2002 VIUS

	Vehicles				Percent			
VMT (1000)	Central	Central veh-miles	Non-Central	Non-Central Veh-Miles	Central	Central Veh-Miles	Non-Central	Non-Central Veh-Miles
0	11054	0	18352	0	2.96%	0.00%	4.92%	0.00%
5	16924	84620	40557	202785	4.53%	1.03%	10.87%	2.48%
10	19827	198270	36129	361290	5.31%	2.42%	9.68%	4.41%
15	20225	303375	30780	461700	5.42%	3.70%	8.25%	5.64%
20	19598	391960	19704	394080	5.25%	4.79%	5.28%	4.81%
25	17261	431525	29072	726800	4.62%	5.27%	7.79%	8.87%
30	9028	270840	8932	267960	2.42%	3.31%	2.39%	3.27%
35	7313	255955	11853	414855	1.96%	3.13%	3.18%	5.07%
40	5152	206080	8780	351200	1.38%	2.52%	2.35%	4.29%
45	3318	149310	7572	340740	0.89%	1.82%	2.03%	4.16%
50	1790	89500	2504	125200	0.48%	1.09%	0.67%	1.53%
55	2611	143605	2031	111705	0.70%	1.75%	0.54%	1.36%
60	2827	169620		0	0.76%	2.07%	0.00%	0.00%
65	2390	155350	1118	72670	0.64%	1.90%	0.30%	0.89%
70	904	63280		0	0.24%	0.77%	0.00%	0.00%
75	3241	243075	2078	155850	0.87%	2.97%	0.56%	1.90%
80		0		0	0.00%	0.00%	0.00%	0.00%
85	462	39270		0	0.12%	0.48%	0.00%	0.00%
90		0		0	0.00%	0.00%	0.00%	0.00%
95	849	80655	903	85785	0.23%	0.98%	0.24%	1.05%
100	3841	384100	2963	296300	1.03%	4.69%	0.79%	3.62%
125	980	122500	300	37500	0.26%	1.50%	0.08%	0.46%
Total	149595	3782890	223628	4406420	40.08%	46.19%	59.92%	53.81%
	373223	8189310			100.00%	100.00%		

Market Data (Continued)

Class 7 & 8 Vehicle Distribution by Annual VMT and Tractor-Trailers
Vehicle Age 2 or Less

VMT (1000)					
0	0.0%	0.0%	0.00		0.00
5	16.9%	13.5%	0.84	0.84	0.68
10	27.3%	25.5%	2.73		2.55
15	55.8%	61.0%	8.37		9.15
	2695	4134	11.94		12.37
20	21.8%	21.5%	4.37		4.30
25	30.6%	28.2%	7.66		7.04
30	22.4%	28.3%	6.73		8.48
35	25.1%	22.1%	8.78		7.73
	7467	9975	27.54		27.55
40	21.6%	26.0%	8.64		10.38
45	22.4%	11.2%	10.06		5.03
50	33.2%	29.0%	16.62		14.52
55	22.8%	33.8%	12.55		18.60
	7964	7574	47.86		48.54
60	21.1%	23.3%	12.66		13.98
65	22.5%	21.0%	14.65		13.65
70	21.0%	23.0%	14.71		16.10
75	35.4%	32.7%	26.52		24.53
	10677	11963	68.53		68.25
80	24.4%	25.3%	19.51		20.22
85	28.4%	31.6%	24.14		26.89
90	22.7%	16.4%	20.44		14.77
95	24.5%	26.7%	23.26		25.35
	13955	17237	87.36		87.23
100	37.8%	28.3%	37.80		28.32
105	27.8%	16.3%	29.18		17.09
110	13.6%	30.3%	14.94		33.38
115	20.8%	25.1%	23.95		28.81
	9268	25720	105.87		107.61
120	13.4%	26.8%	16.06		32.11
125	54.4%	36.5%	68.03		45.62
130	15.6%	18.8%	20.30		24.39
135	16.6%	18.0%	22.37		24.27
	13440	37554	126.77		126.40
140	23.8%	32.2%	33.34		45.04
145	21.1%	27.7%	30.63		40.16
150	34.1%	27.7%	51.21		41.51
155	20.9%	12.5%	32.43		19.31
	7495	12803	147.61		146.02
160	11.8%	15.9%	18.96		25.52
165	9.2%	9.3%	15.26		15.41
170	10.3%	6.6%	17.51		11.26
175	8.3%	5.3%	14.57		9.24
	2977	4762	66.29		61.43
180	41.8%	17.2%	75.29		30.97
185	12.4%	33.4%	22.88		61.71
190	19.4%	31.7%	36.80		60.26
195	26.4%	17.7%	51.55		34.57
	1585	2860	186.52		187.50
200	100.0%	100.0%	200.00		200.00
225	0.0%	0.0%	0.00		0.00
	153	711	200.00		200.00

Market Data (Continued)

Class 7 & 8 Vehicle Distribution by Annual VMT and Single Unit (normal diesel and gas)
Vehicle Age 2 or Less

VMT (1000)				
0	0.0%	0.0%	0.00	0.00
5	15.0%	26.6%	0.75	1.33
10	46.2%	42.4%	4.62	4.24
15	38.9%	31.0%	5.83	4.64
	14043	13055	11.19	10.22
20	28.7%	27.5%	5.75	5.50
25	25.9%	24.4%	6.48	6.09
30	28.1%	24.3%	8.42	7.29
35	17.3%	23.9%	6.05	8.35
	16940	19154	26.69	27.23
40	35.3%	35.7%	14.12	14.27
45	28.6%	30.0%	12.89	13.52
50	24.4%	17.2%	12.20	8.58
55	11.7%	17.1%	6.42	9.42
	5849	5033	45.62	45.79
60	17.3%	23.6%	10.36	14.19
65	26.0%	11.4%	16.87	7.40
70	15.1%	53.1%	10.55	37.17
75	41.7%	11.9%	31.28	8.90
	2235	2030	69.06	67.66
80	27.0%	67.5%	21.61	54.00
85	5.1%	7.3%	4.32	6.24
90	58.6%	19.1%	52.74	17.20
95	9.3%	6.0%	8.83	5.73
	570	994	87.51	83.18
100	58.7%	47.2%	58.68	47.17
105	41.3%	45.0%	43.39	47.26
110	0.0%	7.8%	0.00	8.60
115	0.0%	0.0%	0.00	0.00
	484	371	102.07	103.03
120	0.0%	0.0%	0.00	0.00
125	0.0%	0.0%	0.00	0.00
130	0.0%	79.8%	0.00	103.70
135	0.0%	20.2%	0.00	27.31
	0	262	0.00	131.01
140	100.0%	13.6%	140.00	19.11
145	0.0%	3.0%	0.00	4.30
150	0.0%	0.0%	0.00	0.00
155	0.0%	83.4%	0.00	129.24
	156	337	140.00	152.66
160	0.0%	0.0%	0.00	0.00
165	0.0%	0.0%	0.00	0.00
170	0.0%	0.0%	0.00	0.00
175	0.0%	0.0%	0.00	0.00
	0	0	0.00	0.00
180	0.0%	100.0%	0.00	180.00
185	0.0%	0.0%	0.00	0.00
190	0.0%	0.0%	0.00	0.00
195	0.0%	0.0%	0.00	0.00
	0	38	0.00	180.00
200	100.0%	0.0%	200.00	0.00
225	0.0%	0.0%	0.00	0.00
	39	0	200.00	0.00

Market Data (Continued)

Class 7&8 Vehicle Distribution by Annual VMT and Primary Refueling
Vehicle Age 2 or Less

VMT (1000)				
0.0%	16.2%	14.6%	0.00	0.00
500.0%	24.9%	32.2%	1.24	1.61
1000.0%	29.1%	28.7%	2.91	2.87
1500.0%	29.7%	24.5%	4.46	3.67
	68030	125818	8.62	8.15
2000.0%	36.8%	28.3%	7.37	5.67
2500.0%	32.4%	41.8%	8.11	10.45
3000.0%	17.0%	12.8%	5.09	3.85
3500.0%	13.7%	17.0%	4.81	5.96
	53200	69561	25.38	25.93
4000.0%	40.0%	42.0%	16.01	16.81
4500.0%	25.8%	36.3%	11.60	16.31
5000.0%	13.9%	12.0%	6.95	5.99
5500.0%	20.3%	9.7%	11.16	5.35
	12871	20887	45.72	44.47
6000.0%	30.2%	0.0%	18.12	0.00
6500.0%	25.5%	35.0%	16.59	22.74
7000.0%	9.7%	0.0%	6.76	0.00
7500.0%	34.6%	65.0%	25.96	48.76
	9362	3196	67.43	71.50
8000.0%	0.0%	0.0%	0.00	0.00
8500.0%	35.2%	0.0%	29.95	0.00
9000.0%	0.0%	0.0%	0.00	0.00
9500.0%	64.8%	100.0%	61.52	95.00
	1311	903	91.48	95.00
10000.0%	0.7%	1.3%	0.73	1.31
10500.0%	0.2%	0.1%	0.20	0.14
11000.0%	28.4%	98.6%	31.19	108.42
11500.0%	70.7%	0.0%	81.34	0.00
	527639	226891	113.45	109.86
12000.0%	0.0%	0.0%	0.00	0.00
12500.0%	0.0%	0.0%	0.00	0.00
13000.0%	0.0%	0.0%	0.00	0.00
13500.0%	0.0%	0.0%	0.00	0.00
	0	0	127.50	127.50
14000.0%	0.0%	0.0%	0.00	0.00
14500.0%	0.0%	0.0%	0.00	0.00
15000.0%	0.0%	0.0%	0.00	0.00
15500.0%	0.0%	0.0%	0.00	0.00
	0	0	147.50	147.50
16000.0%	0.0%	0.0%	0.00	0.00
16500.0%	0.0%	0.0%	0.00	0.00
17000.0%	0.0%	0.0%	0.00	0.00
17500.0%	0.0%	0.0%	0.00	0.00
	0	0	167.50	167.50
18000.0%	0.0%	0.0%	0.00	0.00
18500.0%	0.0%	0.0%	0.00	0.00
19000.0%	0.0%	0.0%	0.00	0.00
19500.0%	0.0%	0.0%	0.00	0.00
	0	0	187.50	187.50
20000.0%	0.0%	0.0%	0.00	0.00
22500.0%	0.0%	0.0%	0.00	0.00
	0	0	212.50	212.50

Class 7 & 8 Vehicle Distribution by Annual VMT and Tractor-Trailers
Vehicle Age 2 or Less

Combination Units

VMT	Central	Non-Central	Central	Veh-miles	Non-Central	Veh-miles	Type 1
0-19.9	11944	12373	1.27%	0.15%	1.94%	0.24%	3.21%
20-39.9	27539	27547	3.51%	0.98%	4.68%	1.31%	8.19%
40-59.9	47864	48537	3.74%	1.81%	3.56%	1.75%	7.30%
60-79.9	68532	68255	5.01%	3.48%	5.62%	3.88%	10.63%
80-99.9	87365	87225	6.55%	5.79%	8.09%	7.14%	14.65%
100-119.9	105872	107607	4.35%	4.66%	12.08%	13.15%	16.43%
120-139.9	126769	126398	6.31%	8.10%	17.63%	22.55%	23.94%
140-159.9	147608	146021	3.52%	5.26%	6.01%	8.88%	9.53%
160-179.9	66293	61432	1.40%	2.36%	2.24%	3.74%	3.63%
180-199.9	0	0	0.74%	1.40%	1.34%	2.55%	2.09%
200+	200000	200000	0.07%	0.15%	0.33%	0.68%	0.41%
totals	889785	885395	36.47%	34.14%	63.53%	65.86%	100.00%

Class 7 & 8 Vehicle Distribution by Annual VMT and Single Unit (normal diesel and gas)
Vehicle Age 2 or Less

Single Unit

VMT	Central	Non-Central	Central	Veh-Miles	Non-Centra	Veh-Miles	Type2
0-19.9	11195	10218	17.21%	6.56%	16.00%	5.57%	33.21%
20-39.9	26695	27226	20.76%	18.88%	23.48%	21.77%	44.24%
40-59.9	45623	45788	7.17%	11.14%	6.17%	9.62%	13.34%
60-79.9	69060	67660	2.74%	6.44%	2.49%	5.73%	5.23%
80-99.9	87509	83184	0.70%	2.08%	1.22%	3.45%	1.92%
100-119.9	102066	103032	0.59%	2.06%	0.45%	1.60%	1.05%
120-139.9	127500	131011	0.00%	0.00%	0.32%	1.43%	0.32%
140-159.9	140000	152656	0.19%	0.91%	0.41%	2.15%	0.60%
160-179.9	167500	167500	0.00%	0.00%	0.00%	0.00%	0.00%
180-199.9	187500	0	0.00%	0.00%	0.05%	0.29%	0.05%
200+	200000	212500	0.05%	0.33%	0.00%	0.00%	0.05%
	1164648	1000776	49.41%	48.40%	50.59%	51.60%	100.00%

Combination Units

Enhancement B Fuel Type	Diesel Fuel (Enhancemant A Default Fuel Type = Diesel Fuel)
Discount Rate	8%
Annual VMT	200000
Fuel Efficiency Escalator	1.000

Not including first cost of enhancement

MPg Incr/yr: 1

Year	Baseline Fuel Efficiency MPG	Enhancement A Efficiency Improvement	Enhancement A Adjusted MPG	Enhancement B Efficiency Improvement	Enhancement B Adjusted MPG	Enhancement B Fuel Cost ($/gal-ge)	ANNUAL OPERATING COST OF ALL OPTIONS			ANNUAL DOLLAR SAVINGS OF ENHANCEMENTS	
							Baseline	Enhancement A	Enhancement B	Enhancement A	Enhancement B
1995	6.09	1.000	6.09	1.000	6.09	$0.00	$0	$0	$0	$0	$0
1996	6.09	1.000	6.09	1.000	6.09	$0.00	$0	$0	$0	$0	$0
1997	6.09	1.000	6.09	1.000	6.09	$0.00	$0	$0	$0	$0	$0
1998	6.09	1.000	6.09	1.000	6.09	$0.00	$0	$0	$0	$0	$0
1999	6.09	1.000	6.09	1.000	6.09	$0.00	$0	$0	$0	$0	$0
2000	6.09	1.000	6.09	1.000	6.09	$1.52	$50,058	$50,058	$50,058	$0	$0
2001	6.09	1.000	6.09	1.000	6.09	$1.41	$46,278	$46,278	$46,278	$0	$0
2002	6.09	1.000	6.09	1.000	6.09	$1.33	$43,515	$43,515	$43,515	$0	$0
2003	6.09	1.000	6.09	1.000	6.09	$1.56	$51,194	$51,194	$51,194	$0	$0
2004	6.09	1.000	6.09	1.000	6.09	$1.84	$60,331	$60,331	$60,331	$0	$0
2005	6.09	1.100	6.70	1.000	6.09	$2.36	$77,404	$70,368	$77,404	$7,037	$0
2006	6.09	1.138	6.93	1.000	6.09	$2.38	$78,144	$68,678	$78,144	$9,466	$0
2007	6.09	1.176	7.16	1.000	6.09	$2.13	$69,832	$59,397	$69,832	$10,434	$0
2008	6.09	1.214	7.39	1.000	6.09	$2.09	$68,621	$56,548	$68,621	$12,073	$0
2009	6.09	1.251	7.62	1.000	6.09	$2.03	$66,644	$53,258	$66,644	$13,386	$0
2010	6.09	1.289	7.85	1.000	6.09	$1.98	$65,082	$50,483	$65,082	$14,598	$0
2011	6.09	1.289	7.85	1.000	6.09	$2.02	$66,186	$51,340	$66,186	$14,846	$0
2012	6.09	1.289	7.85	1.000	6.09	$2.00	$65,731	$50,987	$65,731	$14,744	$0
2013	6.09	1.289	7.85	1.000	6.09	$2.02	$66,186	$51,340	$66,186	$14,846	$0
2014	6.09	1.289	7.85	1.000	6.09	$1.99	$65,434	$50,757	$65,434	$14,678	$0
2015	6.09	1.289	7.85	1.000	6.09	$2.02	$66,305	$51,432	$66,305	$14,873	$0
2016	6.09	1.341	8.16	1.000	6.09	$2.02	$66,197	$49,382	$66,197	$16,816	$0
2017	6.09	1.392	8.48	1.000	6.09	$2.01	$66,104	$47,493	$66,104	$18,611	$0
2018	6.09	1.443	8.79	1.000	6.09	$2.04	$66,838	$46,311	$66,838	$20,527	$0
2019	6.09	1.495	9.10	1.000	6.09	$2.03	$66,755	$44,665	$66,755	$22,090	$0
2020	6.09	1.546	9.41	1.000	6.09	$2.05	$67,322	$43,547	$67,322	$23,774	$0
2021	6.09	1.546	9.41	1.000	6.09	$2.06	$67,538	$43,687	$67,538	$23,851	$0
2022	6.09	1.546	9.41	1.000	6.09	$2.06	$67,587	$43,719	$67,587	$23,868	$0
2023	6.09	1.546	9.41	1.000	6.09	$2.08	$68,401	$44,246	$68,401	$24,156	$0
2024	6.09	1.546	9.41	1.000	6.09	$2.09	$68,726	$44,456	$68,726	$24,270	$0
2025	6.09	1.546	9.41	1.000	6.09	$2.10	$69,015	$44,643	$69,015	$24,372	$0
2026	6.09	1.546	9.41	1.000	6.09	$2.13	$69,915	$45,225	$69,915	$24,690	$0
2027	6.09	1.546	9.41	1.000	6.09	$2.14	$70,405	$45,542	$70,405	$24,863	$0
2028	6.09	1.546	9.41	1.000	6.09	$2.17	$71,274	$46,104	$71,274	$25,170	$0
2029	6.09	1.546	9.41	1.000	6.09	$2.14	$70,327	$45,491	$70,327	$24,835	$0
2030	6.09	1.546	9.41	1.000	6.09	$2.17	$71,274	$46,104	$71,274	$25,170	$0
2031	6.09	1.546	9.41	1.000	6.09	$2.18	$71,629	$46,334	$71,629	$25,295	$0
2032	6.09	1.546	9.41	1.000	6.09	$2.19	$71,986	$46,565	$71,986	$25,421	$0
2033	6.09	1.546	9.41	1.000	6.09	$2.20	$72,345	$46,797	$72,345	$25,548	$0
2034	6.09	1.546	9.41	1.000	6.09	$2.21	$72,705	$47,030	$72,705	$25,675	$0
2035	6.09	1.546	9.41	1.000	6.09	$2.22	$73,067	$47,264	$73,067	$25,803	$0
2036	6.09	1.546	9.41	1.000	6.09	$2.24	$73,431	$47,500	$73,431	$25,932	$0
2037	6.09	1.546	9.41	1.000	6.09	$2.25	$73,797	$47,736	$73,797	$26,061	$0
2038	6.09	1.546	9.41	1.000	6.09	$2.26	$74,165	$47,974	$74,165	$26,191	$0
2039	6.09	1.546	9.41	1.000	6.09	$2.27	$74,534	$48,213	$74,534	$26,321	$0
2040	6.09	1.546	9.41	1.000	6.09	$2.28	$74,906	$48,453	$74,906	$26,452	$0
2041	6.09	1.546	9.41	1.000	6.09	$2.29	$75,279	$48,695	$75,279	$26,584	$0
2042	6.09	1.546	9.41	1.000	6.09	$2.30	$75,654	$48,937	$75,654	$26,717	$0
2043	6.09	1.546	9.41	1.000	6.09	$2.32	$76,031	$49,181	$76,031	$26,850	$0
2044	6.09	1.546	9.41	1.000	6.09	$2.33	$76,410	$49,426	$76,410	$26,984	$0
2045	6.09	1.546	9.41	1.000	6.09	$2.34	$76,790	$49,672	$76,790	$27,118	$0
2046	6.09	1.546	9.41	1.000	6.09	$2.35	$77,173	$49,920	$77,173	$27,253	$0
2047	6.09	1.546	9.41	1.000	6.09	$2.36	$77,558	$50,169	$77,558	$27,389	$0
2048	6.09	1.546	9.41	1.000	6.09	$2.37	$77,944	$50,419	$77,944	$27,525	$0
2049	6.09	1.546	9.41	1.000	6.09	$2.39	$78,332	$50,670	$78,332	$27,663	$0
2050	6.09	1.546	9.41	1.000	6.09	$2.40	$78,723	$50,922	$78,723	$27,800	$0

Combination Units (Continued)

MPg Incr/yr:

	INCREMENTAL COST OF ENHANCEMENT A				INCREMENTAL COST OF ENHANCEMENT B				Cost Effectiveness Factor ENHANCEMENT A					Cost Effectiveness FactorEnhancement B			
	Payback Periods (years)				Payback Periods (years)				Payback Periods (years)				Enhan B	Payback Periods (years)			
Year	1	2	3	4	1	2	3	4	1	2	3	4	Cost	1	2	3	4
1995	$0	$0	$0	$0	$0.00	$0.00	$0.00	$0.00	0.00	0.00	0.00	0.00	$0	0.00	0.00	0.00	0.00
1996	$0	$0	$0	$0	$0.00	$0.00	$0.00	$0.00	0.00	0.00	0.00	0.00	$0	0.00	0.00	0.00	0.00
1997	$0	$0	$0	$0	$0.00	$0.00	$0.00	$0.00	0.00	0.00	0.00	0.00	$0	0.00	0.00	0.00	0.00
1998	$0	$0	$0	$0	$0.00	$0.00	$0.00	$0.00	0.00	0.00	0.00	0.00	$0	0.00	0.00	0.00	0.00
1999	$0	$0	$0	$0	$0.00	$0.00	$0.00	$0.00	0.00	0.00	0.00	0.00	$0	0.00	0.00	0.00	0.00
2000	$0	$0	$0	$0	$0.00	$0.00	$0.00	$0.00	0.00	0.00	0.00	0.00	$0	0.00	0.00	0.00	0.00
2001	$0	$0	$0	$0	$0.00	$0.00	$0.00	$0.00	0.00	0.00	0.00	0.00	$0	0.00	0.00	0.00	0.00
2002	$0	$0	$0	$0	$0.00	$0.00	$0.00	$0.00	0.00	0.00	0.00	0.00	$0	0.00	0.00	0.00	0.00
2003	$0	$0	$0	$0	$0.00	$0.00	$0.00	$0.00	0.00	0.00	0.00	0.00	$0	0.00	0.00	0.00	0.00
2004	$0	$0	$0	$0	$0.00	$0.00	$0.00	$0.00	0.00	0.00	0.00	0.00	$0	0.00	0.00	0.00	0.00
2005	$6,608	$12,102	$17,123	$21,660	$0.00	$0.00	$0.00	$0.00	0.00	0.00	0.00	0.00	$45,000	0.00	0.00	0.00	0.00
2006	$7,869	$15,062	$21,561	$27,464	$0.00	$0.00	$0.00	$0.00	0.00	0.00	0.00	0.00	$44,000	0.00	0.00	0.00	0.00
2007	$9,538	$18,155	$25,983	$33,388	$0.00	$0.00	$0.00	$0.00	0.00	0.00	0.00	0.00	$43,000	0.00	0.00	0.00	0.00
2008	$10,907	$20,816	$30,190	$38,849	$0.00	$0.00	$0.00	$0.00	0.00	0.00	0.00	-0.08	$42,000	0.00	0.00	0.00	0.00
2009	$12,160	$23,664	$34,291	$44,246	$0.00	$0.00	$0.00	$0.00	0.00	0.00	-0.04	-0.34	$41,000	0.00	0.00	0.00	0.00
2010	$13,810	$26,569	$38,520	$49,510	$0.00	$0.00	$0.00	$0.00	0.00	0.00	-0.28	-0.65	$40,000	0.00	0.00	0.00	0.00
2011	$13,715	$26,562	$38,377	$49,514	$0.00	$0.00	$0.00	$0.00	0.00	0.00	-0.37	-0.77	$38,000	0.00	0.00	0.00	0.00
2012	$13,810	$26,511	$38,483	$49,602	$0.00	$0.00	$0.00	$0.00	0.00	-0.02	-0.48	-0.91	$36,000	0.00	0.00	0.00	0.00
2013	$13,654	$26,524	$38,476	$49,579	$0.00	$0.00	$0.00	$0.00	0.00	-0.11	-0.60	-1.07	$34,000	0.00	0.00	0.00	0.00
2014	$13,835	$26,684	$38,620	$49,846	$0.00	$0.00	$0.00	$0.00	0.00	-0.21	-0.76	-1.27	$32,000	0.00	0.00	0.00	0.00
2015	$13,813	$26,644	$38,712	$49,924	$0.00	$0.00	$0.00	$0.00	0.00	-0.33	-0.94	-1.50	$30,000	0.00	0.00	0.00	0.00
2016	$15,621	$30,313	$43,963	$56,768	$0.00	$0.00	$0.00	$0.00	0.00	-0.60	-1.31	-1.99	$28,000	0.00	0.00	0.00	0.00
2017	$17,505	$33,769	$49,026	$63,265	$0.00	$0.00	$0.00	$0.00	0.00	-0.88	-1.72	-2.51	$26,000	0.00	0.00	0.00	0.00
2018	$19,071	$36,962	$53,658	$69,201	$0.00	$0.00	$0.00	$0.00	-0.12	-1.17	-2.16	-3.07	$24,000	0.00	0.00	0.00	0.00
2019	$20,724	$40,063	$58,067	$75,016	$0.00	$0.00	$0.00	$0.00	-0.30	-1.50	-2.63	-3.69	$22,000	0.00	0.00	0.00	0.00
2020	$22,187	$42,840	$62,284	$80,458	$0.00	$0.00	$0.00	$0.00	-0.48	-1.86	-3.15	-4.36	$20,000	0.00	0.00	0.00	0.00
2021	$22,203	$43,105	$62,642	$80,892	$0.00	$0.00	$0.00	$0.00	-0.59	-2.08	-3.47	-4.78	$19,000	0.00	0.00	0.00	0.00
2022	$22,470	$43,472	$63,091	$81,579	$0.00	$0.00	$0.00	$0.00	-0.73	-2.34	-3.85	-5.28	$18,000	0.00	0.00	0.00	0.00
2023	$22,577	$43,667	$63,542	$82,159	$0.00	$0.00	$0.00	$0.00	-0.88	-2.64	-4.30	-5.85	$17,000	0.00	0.00	0.00	0.00
2024	$22,672	$44,037	$64,051	$82,898	$0.00	$0.00	$0.00	$0.00	-1.06	-3.00	-4.82	-6.54	$16,000	0.00	0.00	0.00	0.00
2025	$22,967	$44,482	$64,743	$83,340	$0.00	$0.00	$0.00	$0.00	-1.30	-3.45	-5.47	-7.33	$15,000	0.00	0.00	0.00	0.00
2026	$23,128	$44,909	$64,900	$83,748	$0.00	$0.00	$0.00	$0.00	-1.31	-3.49	-5.49	-7.37	$14,000	0.00	0.00	0.00	0.00
2027	$23,414	$44,905	$65,166	$84,107	$0.00	$0.00	$0.00	$0.00	-1.34	-3.49	-5.52	-7.41	$13,000	0.00	0.00	0.00	0.00
2028	$23,103	$44,883	$65,245	$84,280	$0.00	$0.00	$0.00	$0.00	-1.31	-3.49	-5.52	-7.43	$12,000	0.00	0.00	0.00	0.00
2029	$23,414	$45,303	$65,766	$84,896	$0.00	$0.00	$0.00	$0.00	-1.34	-3.53	-5.58	-7.49	$11,000	0.00	0.00	0.00	0.00
2030	$23,531	$45,528	$66,094	$85,319	$0.00	$0.00	$0.00	$0.00	-1.35	-3.55	-5.61	-7.53	$10,000	0.00	0.00	0.00	0.00
2031	$23,648	$45,755	$66,423	$85,744	$0.00	$0.00	$0.00	$0.00	-1.36	-3.58	-5.64	-7.57	$9,520	0.00	0.00	0.00	0.00
2032	$23,766	$45,983	$66,754	$86,172	$0.00	$0.00	$0.00	$0.00	-1.38	-3.60	-5.68	-7.62	$9,040	0.00	0.00	0.00	0.00
2033	$23,884	$46,212	$67,086	$86,601	$0.00	$0.00	$0.00	$0.00	-1.39	-3.62	-5.71	-7.66	$8,560	0.00	0.00	0.00	0.00
2034	$24,003	$46,443	$67,421	$87,032	$0.00	$0.00	$0.00	$0.00	-1.40	-3.64	-5.74	-7.70	$8,080	0.00	0.00	0.00	0.00
2035	$24,123	$46,674	$67,757	$87,466	$0.00	$0.00	$0.00	$0.00	-1.41	-3.67	-5.78	-7.75	$7,600	0.00	0.00	0.00	0.00
2036	$24,243	$46,907	$68,094	$87,902	$0.00	$0.00	$0.00	$0.00	-1.42	-3.69	-5.81	-7.79	$7,600	0.00	0.00	0.00	0.00
2037	$24,364	$47,140	$68,433	$88,340	$0.00	$0.00	$0.00	$0.00	-1.44	-3.71	-5.84	-7.83	$7,600	0.00	0.00	0.00	0.00
2038	$24,485	$47,375	$68,774	$88,780	$0.00	$0.00	$0.00	$0.00	-1.45	-3.74	-5.88	-7.88	$7,600	0.00	0.00	0.00	0.00
2039	$24,607	$47,611	$69,117	$89,222	$0.00	$0.00	$0.00	$0.00	-1.46	-3.76	-5.91	-7.92	$7,600	0.00	0.00	0.00	0.00
2040	$24,730	$47,848	$69,461	$89,667	$0.00	$0.00	$0.00	$0.00	-1.47	-3.78	-5.95	-7.97	$7,600	0.00	0.00	0.00	0.00
2041	$24,853	$48,087	$69,807	$90,113	$0.00	$0.00	$0.00	$0.00	-1.49	-3.81	-5.98	-8.01	$7,600	0.00	0.00	0.00	0.00
2042	$24,977	$48,326	$70,155	$90,562	$0.00	$0.00	$0.00	$0.00	-1.50	-3.83	-6.02	-8.06	$7,600	0.00	0.00	0.00	0.00
2043	$25,101	$48,567	$70,505	$91,014	$0.00	$0.00	$0.00	$0.00	-1.51	-3.86	-6.05	-8.10	$7,600	0.00	0.00	0.00	0.00
2044	$25,226	$48,809	$70,856	$91,467	$0.00	$0.00	$0.00	$0.00	-1.52	-3.88	-6.09	-8.15	$7,600	0.00	0.00	0.00	0.00
2045	$25,352	$49,052	$71,209	$91,923	$0.00	$0.00	$0.00	$0.00	-1.54	-3.91	-6.12	-8.19	$7,600	0.00	0.00	0.00	0.00
2046	$25,478	$49,297	$71,564	$92,381	$0.00	$0.00	$0.00	$0.00	-1.55	-3.93	-6.16	-8.24	$7,600	0.00	0.00	0.00	0.00
2047	$25,605	$49,542	$71,920	$92,841	$0.00	$0.00	$0.00	$0.00	-1.56	-3.95	-6.19	-8.28	$7,600	0.00	0.00	0.00	0.00
2048	$25,733	$49,789	$72,279	$93,304	$0.00	$0.00	$0.00	$0.00	-1.57	-3.98	-6.23	-8.33	$7,600	0.00	0.00	0.00	0.00
2049	$25,861	$50,037	$72,639	$93,769	$0.00	$0.00	$0.00	$0.00	-1.59	-4.00	-6.26	-8.38	$7,600	0.00	0.00	0.00	0.00
2050	$25,990	$50,286	$73,001	$94,236	$0.00	$0.00	$0.00	$0.00	-1.60	-4.03	-6.30	-8.42	$7,600	0.00	0.00	0.00	0.00

Combination Units (Continued)

MPg Incr/yr:

	Tech. Adoption Factor Enhancement A								Tech. Adoption Factor Enhancement B							
	Payback Periods (years)								Payback Periods (years)							
Year	1		2		3		4		1		2		3		4	
1995	1.00E+02	100.0	1.00E+02	100.0	1.0E+02	100.0	1.0E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0
1996	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0
1997	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0
1998	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0
1999	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0
2000	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0
2001	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0
2002	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0
2003	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0
2004	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0
2005	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0
2006	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0
2007	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0
2008	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	9.18E+01	91.8	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0
2009	1.00E+02	100.0	1.00E+02	100.0	9.60E+01	96.0	5.94E+01	59.4	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0
2010	1.00E+02	100.0	1.00E+02	100.0	6.72E+01	67.2	8.38E+00	8.4	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0
2011	1.00E+02	100.0	1.00E+02	100.0	5.51E+01	55.1	-1.56E+01	0.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0
2012	1.00E+02	100.0	9.80E+01	98.0	3.84E+01	38.4	-4.79E+01	0.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0
2013	1.00E+02	100.0	8.89E+01	88.9	1.72E+01	17.2	-9.03E+01	0.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0
2014	1.00E+02	100.0	7.63E+01	76.3	-1.29E+01	0.0	-1.55E+02	0.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0
2015	1.00E+02	100.0	6.06E+01	60.6	-5.49E+01	0.0	-2.46E+02	0.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0
2016	1.00E+02	100.0	1.86E+01	18.6	-1.72E+02	0.0	-5.30E+02	0.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0
2017	1.00E+02	100.0	-4.01E+01	0.0	-3.61E+02	0.0	-1.04E+03	0.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0
2018	8.70E+01	87.0	-1.24E+02	0.0	-6.64E+02	0.0	-1.96E+03	0.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0
2019	6.57E+01	65.7	-2.50E+02	0.0	-1.19E+03	0.0	-3.80E+03	0.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0
2020	3.85E+01	38.5	-4.40E+02	0.0	-2.14E+03	0.0	-7.66E+03	0.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0
2021	2.03E+01	20.3	-6.00E+02	0.0	-3.03E+03	0.0	-1.17E+04	0.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0
2022	-7.19E+00	1.0	-8.42E+02	0.0	-4.51E+03	0.0	-1.93E+04	0.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0
2023	-4.14E+01	1.0	-1.20E+03	0.0	-7.13E+03	0.0	-3.44E+04	0.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0
2024	-8.90E+01	1.0	-1.82E+03	0.0	-1.22E+04	0.0	-6.88E+04	0.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0
2025	-1.66E+02	1.0	-2.94E+03	0.0	-2.36E+04	0.0	-1.53E+05	0.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0
2026	-1.72E+02	1.0	-3.08E+03	0.0	-2.40E+04	0.0	-1.59E+05	0.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0
2027	-1.82E+02	1.0	-3.08E+03	0.0	-2.47E+04	0.0	-1.65E+05	0.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0
2028	-1.71E+02	1.0	-3.07E+03	0.0	-2.49E+04	0.0	-1.68E+05	0.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0
2029	-1.82E+02	1.0	-3.21E+03	0.0	-2.62E+04	0.0	-1.79E+05	0.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0
2030	-1.87E+02	1.0	-3.29E+03	0.0	-2.71E+04	0.0	-1.86E+05	0.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0
2031	-1.91E+02	1.0	-3.37E+03	0.0	-2.80E+04	0.0	-1.95E+05	0.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0
2032	-1.96E+02	1.0	-3.45E+03	0.0	-2.90E+04	0.0	-2.03E+05	0.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0
2033	-2.01E+02	1.0	-3.54E+03	0.0	-2.99E+04	0.0	-2.12E+05	0.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0
2034	-2.06E+02	1.0	-3.63E+03	0.0	-3.10E+04	0.0	-2.21E+05	0.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0
2035	-2.11E+02	1.0	-3.71E+03	0.0	-3.20E+04	0.0	-2.31E+05	0.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0
2036	-2.15E+02	1.0	-3.81E+03	0.0	-3.31E+04	0.0	-2.41E+05	0.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0
2037	-2.21E+02	1.0	-3.90E+03	0.0	-3.43E+04	0.0	-2.52E+05	0.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0
2038	-2.26E+02	1.0	-4.00E+03	0.0	-3.55E+04	0.0	-2.64E+05	0.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0
2039	-2.31E+02	1.0	-4.10E+03	0.0	-3.67E+04	0.0	-2.76E+05	0.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0
2040	-2.36E+02	1.0	-4.20E+03	0.0	-3.80E+04	0.0	-2.88E+05	0.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0
2041	-2.42E+02	1.0	-4.31E+03	0.0	-3.94E+04	0.0	-3.01E+05	0.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0
2042	-2.47E+02	1.0	-4.42E+03	0.0	-4.08E+04	0.0	-3.15E+05	0.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0
2043	-2.53E+02	1.0	-4.53E+03	0.0	-4.22E+04	0.0	-3.30E+05	0.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0
2044	-2.58E+02	1.0	-4.65E+03	0.0	-4.37E+04	0.0	-3.45E+05	0.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0
2045	-2.64E+02	1.0	-4.77E+03	0.0	-4.53E+04	0.0	-3.61E+05	0.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0
2046	-2.70E+02	1.0	-4.89E+03	0.0	-4.70E+04	0.0	-3.78E+05	0.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0
2047	-2.76E+02	1.0	-5.02E+03	0.0	-4.87E+04	0.0	-3.96E+05	0.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0
2048	-2.82E+02	1.0	-5.15E+03	0.0	-5.05E+04	0.0	-4.15E+05	0.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0
2049	-2.88E+02	1.0	-5.28E+03	0.0	-5.23E+04	0.0	-4.34E+05	0.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0
2050	-2.95E+02	1.0	-5.42E+03	0.0	-5.43E+04	0.0	-4.55E+05	0.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0	1.00E+02	100.0

Combination Units (Continued)

MPg Incr/yr:	Market Penetration Enhancement A						Market Penetration Enhancement B					
	16.4%	61.7%	15.5%	6.4%			16.4%	61.7%	15.5%	6.4%		
		Payback Periods (years)			Final	Final		Payback Periods (years)			Final	Final
Year	1 Year	2 Years	3 Years	4 Years	Step 1	Step 2	1	2	3	4	Step 1	Step 2
1995	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
1996	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
1997	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
1998	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
1999	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2000	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2001	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2002	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2003	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2004	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2005	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2006	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2007	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2008	0.0%	0.0%	0.0%	1.3%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2009	0.0%	0.0%	1.1%	3.2%	0.4%	0.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2010	0.0%	0.0%	2.6%	30.5%	2.3%	2.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2011	0.0%	0.0%	3.7%	99.8%	7.0%	7.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2012	0.0%	1.1%	6.4%	99.8%	8.0%	8.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2013	0.0%	1.4%	16.3%	99.9%	9.8%	9.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2014	0.0%	2.0%	99.8%	99.9%	23.1%	23.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2015	0.0%	3.1%	99.8%	99.9%	23.8%	23.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2016	0.0%	15.0%	99.9%	100.0%	31.1%	31.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2017	0.0%	99.8%	100.0%	100.0%	83.5%	83.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2018	1.4%	99.9%	100.0%	100.0%	83.8%	83.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2019	2.7%	100.0%	100.0%	100.0%	84.0%	84.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2020	6.3%	100.0%	100.0%	100.0%	84.6%	84.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2021	13.7%	100.0%	100.0%	100.0%	85.8%	85.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2022	81.1%	100.0%	100.0%	100.0%	96.9%	96.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2023	85.4%	100.0%	100.0%	100.0%	97.6%	97.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2024	89.3%	100.0%	100.0%	100.0%	98.2%	98.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2025	93.0%	100.0%	100.0%	100.0%	98.9%	98.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2026	93.2%	100.0%	100.0%	100.0%	98.9%	98.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2027	93.6%	100.0%	100.0%	100.0%	98.9%	98.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2028	93.2%	100.0%	100.0%	100.0%	98.9%	98.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2029	93.6%	100.0%	100.0%	100.0%	98.9%	98.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2030	93.7%	100.0%	100.0%	100.0%	99.0%	99.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2031	93.9%	100.0%	100.0%	100.0%	99.0%	99.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2032	94.0%	100.0%	100.0%	100.0%	99.0%	99.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2033	94.1%	100.0%	100.0%	100.0%	99.0%	99.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2034	94.3%	100.0%	100.0%	100.0%	99.1%	99.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2035	94.4%	100.0%	100.0%	100.0%	99.1%	99.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2036	94.5%	100.0%	100.0%	100.0%	99.1%	99.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2037	94.6%	100.0%	100.0%	100.0%	99.1%	99.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2038	94.8%	100.0%	100.0%	100.0%	99.1%	99.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2039	94.9%	100.0%	100.0%	100.0%	99.2%	99.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2040	95.0%	100.0%	100.0%	100.0%	99.2%	99.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2041	95.1%	100.0%	100.0%	100.0%	99.2%	99.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2042	95.2%	100.0%	100.0%	100.0%	99.2%	99.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2043	95.3%	100.0%	100.0%	100.0%	99.2%	99.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2044	95.5%	100.0%	100.0%	100.0%	99.3%	99.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2045	95.6%	100.0%	100.0%	100.0%	99.3%	99.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2046	95.7%	100.0%	100.0%	100.0%	99.3%	99.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2047	95.8%	100.0%	100.0%	100.0%	99.3%	99.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2048	95.9%	100.0%	100.0%	100.0%	99.3%	99.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2049	96.0%	100.0%	100.0%	100.0%	99.3%	99.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2050	96.1%	100.0%	100.0%	100.0%	99.4%	99.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Combination Units (Continued)

MPg Incr/yr:

Class 7-8 Type 1 Market Penetration by Average Annual VMT - Centrally Refueled Enhancement A

(thousands of miles)

Year	0-19.9	20-39.9	40-59.9	60-79.9	80-99.9	100-119.9	120-139.9	140-159.9	160-179.9	180-199.9	200+	Veh-Miles	Veh-Num (th
1995	0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
1996	0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
1997	0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
1998	0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
1999	0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2000	0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2001	0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2002	0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2003	0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2004	0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2005	0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2006	0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2007	0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2008	0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%
2009	0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%	0.0%	0.0%
2010	0	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.0%	0.0%	1.8%	0.0%	0.0%
2011	0	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.2%	0.0%	0.0%	6.9%	0.0%	0.0%
2012	0	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.5%	0.0%	0.0%	7.9%	0.0%	0.0%
2013	0	0.0%	0.0%	0.0%	0.0%	0.1%	0.3%	0.7%	0.0%	0.0%	9.3%	0.1%	0.1%
2014	0	0.0%	0.0%	0.0%	0.0%	0.1%	0.5%	2.4%	0.0%	0.0%	23.0%	0.2%	0.1%
2015	0	0.0%	0.0%	0.0%	0.1%	0.3%	1.0%	7.1%	0.0%	0.0%	23.7%	0.5%	0.4%
2016	0	0.0%	0.0%	0.0%	0.2%	0.9%	7.1%	12.7%	0.0%	0.0%	28.1%	1.3%	1.0%
2017	0	0.0%	0.0%	0.1%	0.6%	7.0%	12.5%	23.8%	0.1%	0.0%	83.5%	2.8%	2.0%
2018	0	0.0%	0.0%	0.4%	6.2%	9.4%	23.6%	27.1%	0.2%	0.0%	83.7%	4.3%	3.3%
2019	0	0.0%	0.1%	0.8%	8.2%	23.3%	26.3%	83.5%	0.6%	0.0%	83.9%	8.2%	6.3%
2020	0	0.0%	0.1%	6.9%	22.9%	24.8%	83.4%	83.7%	3.6%	0.0%	84.2%	14.1%	11.3%
2021	0	0.0%	0.3%	7.2%	23.3%	27.4%	83.5%	83.8%	7.0%	0.0%	84.7%	14.3%	11.5%
2022	0	0.0%	0.5%	8.9%	24.2%	47.5%	83.7%	83.9%	8.3%	0.0%	87.1%	15.4%	12.5%
2023	0	0.0%	0.9%	22.9%	26.2%	83.5%	83.8%	84.0%	12.2%	0.0%	97.1%	17.9%	15.0%
2024	0	0.0%	6.8%	23.5%	39.3%	83.7%	83.9%	84.4%	23.2%	0.0%	97.8%	19.0%	16.3%
2025	0	0.1%	7.9%	24.9%	83.5%	83.8%	84.2%	86.1%	24.3%	0.0%	98.5%	21.8%	19.4%
2026	0	0.1%	7.9%	25.2%	83.5%	83.8%	84.2%	86.4%	24.5%	0.0%	98.6%	21.8%	19.4%
2027	0	0.1%	7.9%	25.2%	83.5%	83.8%	84.3%	87.1%	24.5%	0.0%	98.6%	21.9%	19.5%
2028	0	0.1%	8.0%	25.2%	83.5%	83.8%	84.2%	86.3%	24.5%	0.0%	98.6%	21.8%	19.4%
2029	0	0.1%	8.0%	25.4%	83.5%	83.8%	84.3%	87.1%	24.6%	0.0%	98.6%	21.9%	19.5%
2030	0	0.1%	8.1%	25.6%	83.5%	83.8%	84.3%	87.5%	24.7%	0.0%	98.7%	21.9%	19.5%
2031	0	0.1%	8.1%	25.7%	83.5%	83.8%	84.3%	88.0%	24.8%	0.0%	98.7%	22.0%	19.6%
2032	0	0.1%	8.2%	25.9%	83.5%	83.8%	84.3%	88.6%	24.9%	0.0%	98.7%	22.0%	19.6%
2033	0	0.1%	8.3%	26.1%	83.5%	83.9%	84.4%	89.5%	25.1%	0.0%	98.8%	22.1%	19.6%
2034	0	0.1%	8.3%	26.3%	83.5%	83.9%	84.4%	90.6%	25.2%	0.0%	98.8%	22.1%	19.7%
2035	0	0.1%	8.4%	26.5%	83.5%	83.9%	84.4%	92.2%	25.3%	0.0%	98.8%	22.2%	19.8%
2036	0	0.1%	8.5%	26.7%	83.5%	83.9%	84.4%	94.8%	25.5%	0.0%	98.8%	22.4%	19.9%
2037	0	0.1%	8.6%	26.9%	83.7%	83.9%	84.5%	99.4%	25.6%	0.0%	98.9%	22.7%	20.1%
2038	0	0.1%	8.7%	27.2%	83.7%	83.9%	84.5%	96.8%	25.8%	0.0%	98.9%	22.5%	20.0%
2039	0	0.1%	8.8%	27.5%	83.7%	83.9%	84.6%	96.8%	25.9%	0.0%	98.9%	22.6%	20.0%
2040	0	0.1%	8.9%	27.8%	83.7%	83.9%	84.6%	96.8%	26.1%	0.0%	98.9%	22.6%	20.0%
2041	0	0.1%	9.1%	28.2%	83.7%	83.9%	84.6%	96.9%	26.3%	0.0%	98.9%	22.6%	20.1%
2042	0	0.1%	9.2%	28.6%	83.7%	83.9%	84.7%	96.9%	26.5%	0.0%	99.0%	22.6%	20.1%
2043	0	0.1%	9.4%	29.0%	83.7%	83.9%	84.7%	97.0%	26.8%	0.0%	99.0%	22.7%	20.2%
2044	0	0.1%	9.6%	29.5%	83.7%	83.9%	84.8%	97.0%	27.0%	0.0%	99.0%	22.7%	20.2%
2045	0	0.1%	9.8%	30.0%	83.7%	84.0%	84.9%	97.1%	27.3%	0.0%	99.0%	22.7%	20.2%
2046	0	0.1%	10.0%	30.7%	83.7%	84.0%	84.9%	97.1%	27.6%	0.0%	99.1%	22.8%	20.3%
2047	0	0.1%	10.3%	31.4%	83.7%	84.0%	85.0%	97.1%	27.9%	0.0%	99.1%	22.8%	20.3%
2048	0	0.1%	10.7%	32.2%	83.7%	84.0%	85.1%	97.2%	28.3%	0.0%	99.1%	22.9%	20.4%
2049	0	0.1%	11.1%	33.2%	83.7%	84.0%	85.2%	97.2%	28.7%	0.0%	99.1%	22.9%	20.5%
2050	0	0.1%	11.6%	34.3%	83.7%	84.0%	85.3%	97.3%	29.1%	0.0%	99.1%	23.0%	20.6%

Combination Units (Continued)

MPg Incr/yr:

Class 7-8 Type 1 Market Penetration by Average Annual VMT - Non-Centrally Refueled Enhancement A

Year	(thousands of miles) 0-19.9	20-39.9	40-59.9	60-79.9	80-99.9	100-119.9	120-139.9	140-159.9	160-179.9	180-199.9	200+	Veh-Miles	Veh-Num
1995	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
1996	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
1997	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
1998	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
1999	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2000	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2001	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2002	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2003	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2004	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2005	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2006	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2007	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2008	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%
2009	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%	0.0%	0.0%
2010	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.0%	0.0%	1.8%	0.0%	0.0%
2011	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.2%	0.0%	0.0%	6.9%	0.1%	0.0%
2012	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.4%	0.0%	0.0%	7.9%	0.1%	0.1%
2013	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.3%	0.7%	0.0%	0.0%	9.3%	0.2%	0.1%
2014	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.5%	1.9%	0.0%	0.0%	23.0%	0.5%	0.3%
2015	0.0%	0.0%	0.0%	0.0%	0.1%	0.4%	1.0%	7.0%	0.0%	0.0%	23.7%	1.1%	0.7%
2016	0.0%	0.0%	0.0%	0.0%	0.2%	1.0%	7.1%	11.3%	0.0%	0.0%	28.1%	2.9%	2.2%
2017	0.0%	0.0%	0.0%	0.1%	0.6%	7.1%	12.1%	23.6%	0.1%	0.0%	83.5%	6.4%	4.7%
2018	0.0%	0.0%	0.0%	0.4%	5.6%	10.1%	23.6%	26.6%	0.1%	0.0%	83.7%	10.0%	7.7%
2019	0.0%	0.0%	0.1%	0.8%	8.2%	23.4%	26.2%	83.4%	0.4%	0.0%	83.9%	17.6%	13.5%
2020	0.0%	0.0%	0.1%	6.9%	22.9%	25.1%	83.4%	83.7%	0.9%	0.0%	84.2%	32.1%	25.3%
2021	0.0%	0.0%	0.4%	7.2%	23.3%	28.6%	83.5%	83.7%	3.4%	0.0%	84.7%	32.7%	25.9%
2022	0.0%	0.0%	0.5%	8.8%	24.2%	83.4%	83.7%	83.8%	7.0%	0.0%	87.1%	40.2%	32.8%
2023	0.0%	0.0%	1.0%	22.9%	26.1%	83.5%	83.8%	84.0%	8.5%	0.0%	97.1%	41.1%	33.9%
2024	0.0%	0.0%	6.9%	23.5%	38.6%	83.7%	83.9%	84.3%	17.7%	0.0%	97.8%	42.5%	35.4%
2025	0.0%	0.1%	8.0%	24.9%	83.5%	83.8%	84.2%	85.7%	23.5%	0.0%	98.5%	46.2%	39.4%
2026	0.0%	0.1%	8.1%	25.1%	83.5%	83.8%	84.2%	85.9%	23.5%	0.0%	98.6%	46.3%	39.4%
2027	0.0%	0.1%	8.1%	25.1%	83.5%	83.8%	84.2%	86.4%	23.5%	0.0%	98.6%	46.3%	39.5%
2028	0.0%	0.1%	8.1%	25.1%	83.5%	83.8%	84.2%	85.9%	23.5%	0.0%	98.6%	46.3%	39.4%
2029	0.0%	0.1%	8.2%	25.3%	83.5%	83.8%	84.2%	86.4%	23.6%	0.0%	98.6%	46.3%	39.5%
2030	0.0%	0.1%	8.3%	25.4%	83.5%	83.9%	84.3%	86.7%	23.7%	0.0%	98.7%	46.4%	39.5%
2031	0.0%	0.1%	8.3%	25.6%	83.5%	83.9%	84.3%	87.0%	23.7%	0.0%	98.7%	46.4%	39.6%
2032	0.0%	0.1%	8.4%	25.7%	83.5%	83.9%	84.3%	87.4%	23.8%	0.0%	98.7%	46.5%	39.6%
2033	0.0%	0.1%	8.5%	25.9%	83.5%	83.9%	84.3%	87.9%	23.8%	0.0%	98.8%	46.5%	39.7%
2034	0.0%	0.1%	8.6%	26.1%	83.5%	83.9%	84.4%	88.5%	23.9%	0.0%	98.8%	46.6%	39.7%
2035	0.0%	0.1%	8.7%	26.3%	83.5%	83.9%	84.4%	89.3%	23.9%	0.0%	98.8%	46.7%	39.8%
2036	0.0%	0.1%	8.8%	26.5%	83.5%	83.9%	84.4%	90.4%	24.0%	0.0%	98.8%	46.8%	39.9%
2037	0.0%	0.1%	8.9%	26.7%	83.7%	83.9%	84.5%	91.9%	24.1%	0.0%	98.9%	47.0%	40.0%
2038	0.0%	0.1%	9.0%	27.0%	83.7%	83.9%	84.5%	94.2%	24.1%	0.0%	98.9%	47.2%	40.2%
2039	0.0%	0.1%	9.2%	27.3%	83.7%	83.9%	84.5%	98.3%	24.2%	0.0%	98.9%	47.6%	40.5%
2040	0.0%	0.1%	9.3%	27.6%	83.7%	83.9%	84.6%	96.7%	24.3%	0.0%	98.9%	47.5%	40.4%
2041	0.0%	0.1%	9.5%	27.9%	83.7%	83.9%	84.6%	96.8%	24.3%	0.0%	98.9%	47.5%	40.4%
2042	0.0%	0.1%	9.7%	28.2%	83.7%	84.0%	84.7%	96.8%	24.4%	0.0%	99.0%	47.6%	40.5%
2043	0.0%	0.1%	10.0%	28.6%	83.7%	84.0%	84.7%	96.9%	24.5%	0.0%	99.0%	47.6%	40.5%
2044	0.0%	0.1%	10.3%	29.1%	83.7%	84.0%	84.8%	96.9%	24.6%	0.0%	99.0%	47.6%	40.6%
2045	0.0%	0.1%	10.6%	29.6%	83.7%	84.0%	84.8%	97.0%	24.7%	0.0%	99.0%	47.7%	40.6%
2046	0.0%	0.1%	11.0%	30.1%	83.7%	84.0%	84.9%	97.0%	24.8%	0.0%	99.1%	47.7%	40.7%
2047	0.0%	0.1%	11.5%	30.8%	83.7%	84.0%	85.0%	97.0%	24.9%	0.0%	99.1%	47.8%	40.8%
2048	0.0%	0.1%	12.1%	31.5%	83.7%	84.0%	85.0%	97.1%	25.0%	0.0%	99.1%	47.9%	40.8%
2049	0.0%	0.1%	12.9%	32.4%	83.7%	84.0%	85.1%	97.1%	25.1%	0.0%	99.1%	47.9%	40.9%
2050	0.0%	0.1%	14.0%	33.4%	83.7%	84.0%	85.2%	97.2%	25.3%	0.0%	99.1%	48.0%	41.1%

Combination Units (Continued)

MPg Incr/yr:

Class 7-8 Type 1 Incremental Cost vs Average Annual VMT - Centrally Refueled Enhancement A-Payback Period = 1 Yr

(thousands of miles) — **Payback Period (yrs): 1**

Year	0-19.9	20-39.9	40-59.9	60-79.9	80-99.9	100-119.9	120-139.9	140-159.9	160-179.9	180-199.9	200+
1995	0	0	0	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	0	0	0	0	0	0
1998	0	0	0	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0	0
2005	395	910	1,581	2,264	2,887	3,498	4,189	4,877	2,190	0	6,608
2006	467	1,077	1,872	2,681	3,417	4,141	4,959	5,774	2,593	0	7,823
2007	565	1,302	2,262	3,240	4,130	5,005	5,992	6,977	3,134	0	9,454
2008	645	1,486	2,583	3,698	4,714	5,713	6,841	7,965	3,577	0	10,792
2009	718	1,655	2,876	4,118	5,250	6,362	7,618	8,871	3,984	0	12,019
2010	815	1,878	3,265	4,674	5,959	7,221	8,647	10,068	4,522	0	13,641
2011	809	1,865	3,242	4,642	5,918	7,172	8,587	9,999	4,491	0	13,548
2012	815	1,878	3,265	4,674	5,959	7,221	8,647	10,068	4,522	0	13,641
2013	805	1,857	3,228	4,621	5,891	7,139	8,548	9,954	4,470	0	13,486
2014	816	1,882	3,270	4,683	5,970	7,234	8,662	10,086	4,530	0	13,666
2015	815	1,879	3,265	4,675	5,960	7,222	8,648	10,070	4,522	0	13,644
2016	906	2,088	3,629	5,196	6,623	8,026	9,611	11,190	5,026	0	15,162
2017	1,003	2,312	4,018	5,753	7,334	8,887	10,641	12,391	5,565	0	16,789
2018	1,083	2,497	4,340	6,215	7,922	9,601	11,496	13,385	6,012	0	18,136
2019	1,170	2,697	4,688	6,713	8,557	10,370	12,417	14,458	6,493	0	19,589
2020	1,247	2,875	4,997	7,155	9,122	11,054	13,236	15,411	6,921	0	20,882
2021	1,248	2,877	5,001	7,160	9,128	11,062	13,245	15,423	6,926	0	20,897
2022	1,263	2,912	5,061	7,247	9,238	11,195	13,405	15,608	7,010	0	21,149
2023	1,269	2,926	5,085	7,281	9,282	11,248	13,469	15,683	7,043	0	21,249
2024	1,274	2,938	5,107	7,312	9,321	11,296	13,525	15,749	7,073	0	21,338
2025	1,291	2,976	5,173	7,407	9,443	11,443	13,701	15,954	7,165	0	21,616
2026	1,300	2,997	5,209	7,459	9,509	11,523	13,798	16,066	7,215	0	21,768
2027	1,316	3,034	5,274	7,551	9,626	11,665	13,968	16,264	7,304	0	22,037
2028	1,299	2,994	5,204	7,451	9,498	11,510	13,782	16,048	7,207	0	21,744
2029	1,316	3,034	5,274	7,551	9,626	11,665	13,968	16,264	7,304	0	22,037
2030	1,323	3,049	5,300	7,589	9,674	11,723	14,037	16,345	7,341	0	22,146
2031	1,329	3,065	5,326	7,627	9,722	11,782	14,107	16,426	7,377	0	22,257
2032	1,336	3,080	5,353	7,665	9,771	11,841	14,178	16,508	7,414	0	22,368
2033	1,342	3,095	5,380	7,703	9,819	11,900	14,248	16,591	7,451	0	22,479
2034	1,349	3,111	5,406	7,741	9,868	11,959	14,319	16,673	7,488	0	22,591
2035	1,356	3,126	5,433	7,780	9,917	12,018	14,391	16,756	7,525	0	22,704
2036	1,363	3,142	5,460	7,818	9,967	12,078	14,462	16,840	7,563	0	22,817
2037	1,369	3,157	5,488	7,857	10,017	12,138	14,534	16,924	7,601	0	22,930
2038	1,376	3,173	5,515	7,897	10,066	12,199	14,607	17,008	7,638	0	23,045
2039	1,383	3,189	5,542	7,936	10,117	12,260	14,679	17,093	7,677	0	23,160
2040	1,390	3,205	5,570	7,975	10,167	12,321	14,753	17,178	7,715	0	23,275
2041	1,397	3,221	5,598	8,015	10,218	12,382	14,826	17,263	7,753	0	23,391
2042	1,404	3,237	5,626	8,055	10,269	12,444	14,900	17,349	7,792	0	23,507
2043	1,411	3,253	5,654	8,095	10,320	12,506	14,974	17,436	7,831	0	23,625
2044	1,418	3,269	5,682	8,136	10,371	12,568	15,049	17,523	7,870	0	23,742
2045	1,425	3,285	5,710	8,176	10,423	12,631	15,124	17,610	7,909	0	23,861
2046	1,432	3,302	5,739	8,217	10,475	12,694	15,199	17,698	7,948	0	23,979
2047	1,439	3,318	5,767	8,258	10,527	12,757	15,275	17,786	7,988	0	24,099
2048	1,446	3,335	5,796	8,299	10,579	12,821	15,351	17,875	8,028	0	24,219
2049	1,454	3,351	5,825	8,340	10,632	12,884	15,427	17,964	8,068	0	24,340
2050	1,461	3,368	5,854	8,382	10,685	12,949	15,504	18,053	8,108	0	24,461

Combination Units (Continued)

MPg Incr/yr:

Class 7-8 Type 1 Incremental Cost vs Average Annual VMT - Centrally Refueled Enhancement A

Year	(thousands of miles) 0-19.9	20-39.9	40-59.9	60-79.9	80-99.9	100-119.9	120-139.9	140-159.9	**Payback Period (yrs): 2** 160-179.9	180-199.9	200+	Veh-Mile Weighted Avg
1995	0	0	0	0	0	0	0	0	0	0	0	$0
1996	0	0	0	0	0	0	0	0	0	0	0	$0
1997	0	0	0	0	0	0	0	0	0	0	0	$0
1998	0	0	0	0	0	0	0	0	0	0	0	$0
1999	0	0	0	0	0	0	0	0	0	0	0	$0
2000	0	0	0	0	0	0	0	0	0	0	0	$0
2001	0	0	0	0	0	0	0	0	0	0	0	$0
2002	0	0	0	0	0	0	0	0	0	0	0	$0
2003	0	0	0	0	0	0	0	0	0	0	0	$0
2004	0	0	0	0	0	0	0	0	0	0	0	$0
2005	723	1,666	2,896	4,147	5,286	6,406	7,671	8,932	4,011	0	12,102	$2,022
2006	894	2,062	3,584	5,131	6,541	7,927	9,492	11,052	4,964	0	14,975	$2,502
2007	1,075	2,478	4,307	6,166	7,861	9,526	11,406	13,281	5,965	0	17,995	$3,006
2008	1,230	2,836	4,929	7,058	8,997	10,903	13,055	15,201	6,827	0	20,596	$3,441
2009	1,397	3,221	5,597	8,015	10,217	12,381	14,825	17,262	7,753	0	23,389	$3,907
2010	1,567	3,614	6,281	8,993	11,464	13,892	16,635	19,369	8,699	0	26,244	$4,384
2011	1,567	3,613	6,279	8,991	11,461	13,889	16,630	19,364	8,697	0	26,237	$4,383
2012	1,564	3,606	6,267	8,973	11,439	13,862	16,598	19,327	8,680	0	26,187	$4,375
2013	1,565	3,607	6,270	8,977	11,444	13,869	16,606	19,336	8,684	0	26,199	$4,377
2014	1,574	3,629	6,308	9,032	11,514	13,953	16,707	19,453	8,737	0	26,358	$4,403
2015	1,572	3,624	6,298	9,018	11,496	13,932	16,681	19,424	8,723	0	26,318	$4,396
2016	1,757	4,051	7,042	10,082	12,853	15,576	18,650	21,716	9,753	0	29,424	$4,915
2017	1,934	4,459	7,751	11,098	14,147	17,144	20,528	23,903	10,735	0	32,387	$5,410
2018	2,099	4,840	8,412	12,045	15,355	18,607	22,280	25,943	11,651	0	35,151	$5,872
2019	2,262	5,215	9,063	12,977	16,543	20,047	24,004	27,950	12,553	0	37,871	$6,326
2020	2,408	5,552	9,649	13,816	17,613	21,344	25,557	29,758	13,365	0	40,320	$6,736
2021	2,423	5,586	9,709	13,902	17,722	21,476	25,715	29,942	13,447	0	40,570	$6,777
2022	2,444	5,634	9,792	14,020	17,873	21,659	25,934	30,197	13,562	0	40,915	$6,835
2023	2,454	5,659	9,836	14,083	17,953	21,756	26,050	30,332	13,623	0	41,099	$6,866
2024	2,475	5,707	9,919	14,202	18,105	21,940	26,271	30,589	13,738	0	41,447	$6,924
2025	2,500	5,765	10,019	14,346	18,288	22,162	26,536	30,899	13,877	0	41,866	$6,994
2026	2,524	5,820	10,115	14,483	18,463	22,375	26,791	31,195	14,010	0	42,267	$7,061
2027	2,524	5,819	10,114	14,482	18,462	22,373	26,788	31,192	14,009	0	42,263	$7,060
2028	2,523	5,817	10,109	14,475	18,453	22,362	26,775	31,177	14,002	0	42,243	$7,057
2029	2,546	5,871	10,204	14,610	18,625	22,571	27,026	31,469	14,133	0	42,638	$7,123
2030	2,559	5,900	10,255	14,683	18,718	22,683	27,160	31,625	14,203	0	42,850	$7,158
2031	2,572	5,930	10,306	14,756	18,811	22,796	27,296	31,783	14,274	0	43,064	$7,194
2032	2,585	5,959	10,357	14,830	18,905	22,910	27,432	31,941	14,345	0	43,278	$7,230
2033	2,598	5,989	10,409	14,904	18,999	23,024	27,568	32,100	14,417	0	43,494	$7,266
2034	2,610	6,019	10,461	14,978	19,094	23,139	27,706	32,260	14,489	0	43,711	$7,302
2035	2,623	6,049	10,513	15,053	19,189	23,254	27,844	32,421	14,561	0	43,929	$7,338
2036	2,637	6,079	10,565	15,128	19,285	23,370	27,983	32,583	14,633	0	44,147	$7,375
2037	2,650	6,109	10,618	15,203	19,381	23,486	28,122	32,745	14,706	0	44,367	$7,412
2038	2,663	6,139	10,671	15,279	19,477	23,603	28,262	32,908	14,779	0	44,588	$7,449
2039	2,676	6,170	10,724	15,355	19,574	23,721	28,403	33,072	14,853	0	44,811	$7,486
2040	2,689	6,201	10,777	15,431	19,672	23,839	28,544	33,237	14,927	0	45,034	$7,523
2041	2,703	6,232	10,831	15,508	19,770	23,958	28,687	33,402	15,001	0	45,258	$7,560
2042	2,716	6,263	10,885	15,586	19,868	24,077	28,830	33,569	15,076	0	45,484	$7,598
2043	2,730	6,294	10,939	15,663	19,967	24,197	28,973	33,736	15,151	0	45,710	$7,636
2044	2,744	6,325	10,994	15,741	20,067	24,318	29,118	33,904	15,227	0	45,938	$7,674
2045	2,757	6,357	11,049	15,820	20,167	24,439	29,263	34,073	15,303	0	46,167	$7,712
2046	2,771	6,389	11,104	15,898	20,267	24,561	29,408	34,243	15,379	0	46,397	$7,751
2047	2,785	6,420	11,159	15,978	20,368	24,683	29,555	34,414	15,456	0	46,628	$7,789
2048	2,799	6,452	11,215	16,057	20,470	24,806	29,702	34,585	15,533	0	46,860	$7,828
2049	2,813	6,484	11,270	16,137	20,572	24,930	29,850	34,757	15,610	0	47,094	$7,867
2050	2,827	6,517	11,327	16,218	20,674	25,054	29,999	34,930	15,688	0	47,329	$7,906

Combination Units (Continued)

MPg Incr/yr:

Class 7-8 Type 1 Incremental Cost vs Average Annual VMT - Centrally Refueled Enhancement A

Year	(thousands of miles) 0-19.9	20-39.9	40-59.9	60-79.9	80-99.9	100-119.9	120-139.9	140-159.9	Payback Period (yrs): 3 160-179.9	180-199.9	200+	Veh-Mile Weighted Avg
1995	0	0	0	0	0	0	0	0	0	0	0	$0
1996	0	0	0	0	0	0	0	0	0	0	0	$0
1997	0	0	0	0	0	0	0	0	0	0	0	$0
1998	0	0	0	0	0	0	0	0	0	0	0	$0
1999	0	0	0	0	0	0	0	0	0	0	0	$0
2000	0	0	0	0	0	0	0	0	0	0	0	$0
2001	0	0	0	0	0	0	0	0	0	0	0	$0
2002	0	0	0	0	0	0	0	0	0	0	0	$0
2003	0	0	0	0	0	0	0	0	0	0	0	$0
2004	0	0	0	0	0	0	0	0	0	0	0	$0
2005	1,023	2,358	4,098	5,868	7,480	9,064	10,853	12,638	5,676	0	17,123	$2,860
2006	1,280	2,952	5,130	7,345	9,364	11,347	13,587	15,820	7,105	0	21,436	$3,581
2007	1,538	3,546	6,163	8,825	11,250	13,633	16,324	19,007	8,536	0	25,754	$4,302
2008	1,784	4,113	7,149	10,236	13,048	15,812	18,934	22,046	9,901	0	29,871	$4,990
2009	2,024	4,667	8,111	11,614	14,806	17,942	21,483	25,015	11,235	0	33,894	$5,662
2010	2,272	5,239	9,106	13,038	16,620	20,141	24,117	28,081	12,612	0	38,048	$6,356
2011	2,264	5,220	9,072	12,989	16,559	20,067	24,027	27,977	12,565	0	37,908	$6,333
2012	2,270	5,234	9,097	13,025	16,605	20,122	24,094	28,055	12,600	0	38,013	$6,350
2013	2,270	5,233	9,095	13,023	16,602	20,118	24,089	28,050	12,597	0	38,005	$6,349
2014	2,278	5,253	9,129	13,072	16,664	20,194	24,180	28,154	12,645	0	38,148	$6,373
2015	2,284	5,265	9,151	13,103	16,703	20,242	24,237	28,222	12,675	0	38,238	$6,388
2016	2,549	5,876	10,212	14,622	18,641	22,589	27,048	31,495	14,145	0	42,673	$7,129
2017	2,808	6,474	11,253	16,112	20,539	24,890	29,803	34,703	15,585	0	47,020	$7,855
2018	3,048	7,026	12,212	17,486	22,291	27,013	32,344	37,661	16,914	0	51,029	$8,524
2019	3,278	7,558	13,136	18,808	23,977	29,056	34,791	40,510	18,194	0	54,889	$9,169
2020	3,501	8,072	14,029	20,087	25,607	31,031	37,156	43,265	19,431	0	58,621	$9,793
2021	3,521	8,118	14,109	20,202	25,754	31,209	37,370	43,513	19,542	0	58,957	$9,849
2022	3,546	8,176	14,211	20,347	25,938	31,433	37,637	43,825	19,682	0	59,380	$9,920
2023	3,572	8,235	14,312	20,493	26,124	31,658	37,906	44,138	19,823	0	59,804	$9,990
2024	3,600	8,301	14,427	20,657	26,333	31,911	38,210	44,492	19,982	0	60,283	$10,070
2025	3,639	8,390	14,583	20,880	26,618	32,256	38,623	44,973	20,198	0	60,935	$10,179
2026	3,648	8,411	14,618	20,931	26,682	32,335	38,717	45,082	20,247	0	61,083	$10,204
2027	3,663	8,445	14,678	21,016	26,791	32,467	38,875	45,266	20,330	0	61,332	$10,246
2028	3,667	8,455	14,696	21,042	26,824	32,506	38,922	45,321	20,354	0	61,407	$10,258
2029	3,697	8,523	14,813	21,210	27,038	32,766	39,233	45,683	20,517	0	61,897	$10,340
2030	3,715	8,565	14,887	21,316	27,173	32,929	39,429	45,911	20,619	0	62,206	$10,392
2031	3,734	8,608	14,961	21,422	27,308	33,093	39,625	46,139	20,722	0	62,516	$10,443
2032	3,752	8,651	15,036	21,528	27,444	33,258	39,823	46,369	20,825	0	62,827	$10,495
2033	3,771	8,694	15,111	21,636	27,581	33,424	40,021	46,600	20,929	0	63,140	$10,548
2034	3,790	8,737	15,186	21,744	27,719	33,590	40,220	46,832	21,033	0	63,455	$10,600
2035	3,809	8,781	15,262	21,852	27,857	33,758	40,421	47,066	21,138	0	63,771	$10,653
2036	3,827	8,825	15,338	21,961	27,995	33,926	40,622	47,300	21,243	0	64,089	$10,706
2037	3,847	8,869	15,414	22,070	28,135	34,095	40,825	47,536	21,349	0	64,408	$10,759
2038	3,866	8,913	15,491	22,180	28,275	34,265	41,028	47,773	21,455	0	64,729	$10,813
2039	3,885	8,957	15,568	22,291	28,416	34,436	41,232	48,011	21,562	0	65,051	$10,867
2040	3,904	9,002	15,646	22,402	28,558	34,607	41,438	48,250	21,670	0	65,376	$10,921
2041	3,924	9,047	15,723	22,513	28,700	34,780	41,644	48,490	21,778	0	65,701	$10,976
2042	3,943	9,092	15,802	22,625	28,843	34,953	41,852	48,732	21,886	0	66,029	$11,030
2043	3,963	9,137	15,881	22,738	28,987	35,127	42,060	48,975	21,995	0	66,358	$11,085
2044	3,983	9,182	15,960	22,852	29,131	35,302	42,270	49,219	22,105	0	66,688	$11,140
2045	4,003	9,228	16,039	22,965	29,276	35,478	42,480	49,464	22,215	0	67,020	$11,196
2046	4,023	9,274	16,119	23,080	29,422	35,655	42,692	49,710	22,326	0	67,354	$11,252
2047	4,043	9,320	16,199	23,195	29,569	35,832	42,905	49,958	22,437	0	67,690	$11,308
2048	4,063	9,367	16,280	23,310	29,716	36,011	43,119	50,207	22,549	0	68,027	$11,364
2049	4,083	9,414	16,361	23,426	29,864	36,190	43,333	50,457	22,661	0	68,366	$11,421
2050	4,103	9,460	16,443	23,543	30,013	36,371	43,549	50,709	22,774	0	68,707	$11,478

Combination Units (Continued)

MPg Incr/yr:

Class 7-8 Type 1 Incremental Cost vs Average Annual VMT - Centrally Refueled Enhancement A

Year	(thousands of miles) 0-19.9	20-39.9	40-59.9	60-79.9	80-99.9	100-119.9	120-139.9	140-159.9	**Payback Period (yrs): 4** 160-179.9	180-199.9	200+	Veh-Mile Weighted Avg
1995	0	0	0	0	0	0	0	0	0	0	0	$0
1996	0	0	0	0	0	0	0	0	0	0	0	$0
1997	0	0	0	0	0	0	0	0	0	0	0	$0
1998	0	0	0	0	0	0	0	0	0	0	0	$0
1999	0	0	0	0	0	0	0	0	0	0	0	$0
2000	0	0	0	0	0	0	0	0	0	0	0	$0
2001	0	0	0	0	0	0	0	0	0	0	0	$0
2002	0	0	0	0	0	0	0	0	0	0	0	$0
2003	0	0	0	0	0	0	0	0	0	0	0	$0
2004	0	0	0	0	0	0	0	0	0	0	0	$0
2005	1,294	2,982	5,184	7,422	9,462	11,466	13,729	15,986	7,180	0	21,660	$3,618
2006	1,631	3,760	6,535	9,356	11,927	14,454	17,307	20,152	9,051	0	27,305	$4,561
2007	1,976	4,557	7,920	11,340	14,456	17,519	20,976	24,425	10,969	0	33,094	$5,528
2008	2,296	5,293	9,199	13,172	16,791	20,348	24,364	28,370	12,741	0	38,439	$6,421
2009	2,612	6,022	10,466	14,986	19,103	23,150	27,720	32,277	14,496	0	43,733	$7,306
2010	2,921	6,734	11,704	16,758	21,363	25,888	30,998	36,093	16,210	0	48,904	$8,170
2011	2,921	6,734	11,705	16,759	21,364	25,890	31,000	36,096	16,211	0	48,908	$8,170
2012	2,926	6,746	11,725	16,789	21,402	25,936	31,055	36,161	16,240	0	48,995	$8,185
2013	2,925	6,743	11,720	16,781	21,392	25,924	31,041	36,144	16,233	0	48,973	$8,181
2014	2,940	6,779	11,783	16,871	21,508	26,064	31,208	36,339	16,320	0	49,236	$8,225
2015	2,945	6,790	11,802	16,898	21,541	26,105	31,257	36,395	16,346	0	49,314	$8,238
2016	3,291	7,587	13,187	18,882	24,070	29,169	34,927	40,668	18,265	0	55,103	$9,205
2017	3,624	8,355	14,521	20,791	26,505	32,119	38,459	44,781	20,112	0	60,676	$10,136
2018	3,930	9,062	15,749	22,550	28,747	34,837	41,713	48,570	21,814	0	65,810	$10,994
2019	4,235	9,764	16,970	24,298	30,975	37,537	44,946	52,335	23,504	0	70,911	$11,846
2020	4,522	10,427	18,122	25,948	33,079	40,086	47,998	55,888	25,100	0	75,725	$12,650
2021	4,547	10,483	18,220	26,088	33,257	40,302	48,257	56,190	25,236	0	76,134	$12,718
2022	4,585	10,572	18,375	26,310	33,539	40,644	48,667	56,667	25,450	0	76,780	$12,826
2023	4,618	10,647	18,506	26,497	33,778	40,933	49,013	57,070	25,631	0	77,326	$12,918
2024	4,660	10,743	18,672	26,735	34,082	41,302	49,454	57,583	25,861	0	78,022	$13,034
2025	4,684	10,800	18,772	26,878	34,263	41,522	49,717	57,890	25,999	0	78,438	$13,103
2026	4,707	10,853	18,863	27,009	34,431	41,725	49,960	58,174	26,127	0	78,821	$13,167
2027	4,728	10,900	18,944	27,125	34,579	41,904	50,175	58,423	26,239	0	79,159	$13,224
2028	4,737	10,922	18,983	27,181	34,650	41,990	50,278	58,544	26,293	0	79,323	$13,251
2029	4,772	11,002	19,122	27,380	34,903	42,297	50,646	58,971	26,485	0	79,903	$13,348
2030	4,796	11,057	19,217	27,516	35,077	42,508	50,898	59,265	26,617	0	80,301	$13,414
2031	4,820	11,112	19,313	27,653	35,252	42,720	51,152	59,561	26,749	0	80,701	$13,481
2032	4,844	11,167	19,409	27,791	35,428	42,932	51,406	59,857	26,883	0	81,103	$13,548
2033	4,868	11,223	19,506	27,929	35,604	43,146	51,663	60,155	27,017	0	81,507	$13,616
2034	4,892	11,279	19,603	28,068	35,782	43,361	51,920	60,455	27,151	0	81,913	$13,684
2035	4,916	11,335	19,701	28,208	35,960	43,577	52,179	60,756	27,287	0	82,321	$13,752
2036	4,941	11,391	19,799	28,349	36,139	43,795	52,439	61,059	27,422	0	82,731	$13,820
2037	4,965	11,448	19,898	28,490	36,319	44,013	52,700	61,363	27,559	0	83,143	$13,889
2038	4,990	11,505	19,997	28,632	36,500	44,232	52,962	61,669	27,696	0	83,558	$13,958
2039	5,015	11,563	20,096	28,775	36,682	44,452	53,226	61,976	27,834	0	83,974	$14,028
2040	5,040	11,620	20,197	28,918	36,865	44,674	53,492	62,285	27,973	0	84,392	$14,098
2041	5,065	11,678	20,297	29,062	37,048	44,896	53,758	62,595	28,112	0	84,813	$14,168
2042	5,090	11,736	20,398	29,207	37,233	45,120	54,026	62,907	28,253	0	85,235	$14,239
2043	5,116	11,795	20,500	29,352	37,418	45,345	54,295	63,221	28,393	0	85,660	$14,310
2044	5,141	11,854	20,602	29,499	37,605	45,571	54,566	63,536	28,535	0	86,087	$14,381
2045	5,167	11,913	20,705	29,646	37,792	45,798	54,837	63,852	28,677	0	86,516	$14,453
2046	5,193	11,972	20,808	29,793	37,980	46,026	55,111	64,170	28,820	0	86,947	$14,525
2047	5,218	12,032	20,912	29,942	38,170	46,255	55,385	64,490	28,963	0	87,380	$14,597
2048	5,244	12,092	21,016	30,091	38,360	46,486	55,661	64,811	29,108	0	87,815	$14,670
2049	5,271	12,152	21,120	30,241	38,551	46,717	55,939	65,134	29,253	0	88,253	$14,743
2050	5,297	12,212	21,226	30,392	38,743	46,950	56,217	65,459	29,398	0	88,693	$14,816

Combination Units (Continued)

MPg Incr/yr:

Class 7-8 Type 1 Incremental Cost vs Average Annual VMT - Non-Centrally Refueled Enhancement A

Year	(thousands of miles) 0-19.9	20-39.9	40-59.9	60-79.9	80-99.9	100-119.9	120-139.9	140-159.9	Payback Period (yrs): 1 160-179.9	180-199.9	200+	Veh-Mile Weighted Avg
1995	0	0	0	0	0	0	0	0	0	0	0	$0
1996	0	0	0	0	0	0	0	0	0	0	0	$0
1997	0	0	0	0	0	0	0	0	0	0	0	$0
1998	0	0	0	0	0	0	0	0	0	0	0	$0
1999	0	0	0	0	0	0	0	0	0	0	0	$0
2000	0	0	0	0	0	0	0	0	0	0	0	$0
2001	0	0	0	0	0	0	0	0	0	0	0	$0
2002	0	0	0	0	0	0	0	0	0	0	0	$0
2003	0	0	0	0	0	0	0	0	0	0	0	$0
2004	0	0	0	0	0	0	0	0	0	0	0	$0
2005	409	910	1,604	2,255	2,882	3,556	4,176	4,825	2,030	0	6,608	$1,099
2006	484	1,078	1,899	2,670	3,412	4,209	4,944	5,712	2,403	0	7,823	$1,301
2007	585	1,302	2,294	3,226	4,123	5,087	5,975	6,902	2,904	0	9,454	$1,572
2008	668	1,486	2,619	3,683	4,707	5,807	6,821	7,879	3,315	0	10,792	$1,795
2009	744	1,655	2,917	4,102	5,242	6,467	7,596	8,775	3,692	0	12,019	$1,999
2010	844	1,879	3,311	4,655	5,949	7,340	8,621	9,960	4,190	0	13,641	$2,268
2011	838	1,866	3,288	4,623	5,908	7,289	8,562	9,891	4,161	0	13,548	$2,253
2012	844	1,879	3,311	4,655	5,949	7,340	8,621	9,960	4,190	0	13,641	$2,268
2013	834	1,858	3,273	4,603	5,882	7,256	8,523	9,847	4,143	0	13,486	$2,243
2014	845	1,882	3,317	4,664	5,960	7,353	8,637	9,978	4,198	0	13,666	$2,273
2015	844	1,879	3,311	4,656	5,950	7,341	8,623	9,961	4,191	0	13,644	$2,269
2016	938	2,088	3,680	5,175	6,613	8,158	9,582	11,070	4,657	0	15,162	$2,521
2017	1,039	2,312	4,074	5,730	7,322	9,033	10,610	12,258	5,157	0	16,789	$2,792
2018	1,122	2,498	4,401	6,189	7,910	9,758	11,462	13,241	5,571	0	18,136	$3,016
2019	1,212	2,698	4,754	6,685	8,543	10,540	12,380	14,302	6,017	0	19,589	$3,258
2020	1,292	2,876	5,068	7,126	9,107	11,235	13,197	15,246	6,414	0	20,882	$3,472
2021	1,293	2,878	5,071	7,131	9,114	11,243	13,206	15,257	6,419	0	20,897	$3,475
2022	1,308	2,913	5,132	7,217	9,223	11,379	13,366	15,441	6,496	0	21,149	$3,517
2023	1,315	2,927	5,157	7,252	9,267	11,433	13,429	15,514	6,527	0	21,249	$3,534
2024	1,320	2,939	5,179	7,282	9,306	11,481	13,486	15,579	6,554	0	21,338	$3,548
2025	1,337	2,977	5,246	7,377	9,428	11,630	13,661	15,782	6,640	0	21,616	$3,595
2026	1,347	2,998	5,283	7,429	9,494	11,712	13,757	15,893	6,686	0	21,768	$3,620
2027	1,363	3,035	5,348	7,521	9,611	11,857	13,927	16,089	6,769	0	22,037	$3,665
2028	1,345	2,995	5,277	7,421	9,483	11,699	13,742	15,875	6,679	0	21,744	$3,616
2029	1,363	3,035	5,348	7,521	9,611	11,856	13,927	16,089	6,769	0	22,037	$3,665
2030	1,370	3,050	5,375	7,558	9,659	11,916	13,996	16,169	6,803	0	22,146	$3,683
2031	1,377	3,066	5,401	7,596	9,707	11,975	14,066	16,250	6,836	0	22,257	$3,701
2032	1,384	3,081	5,428	7,633	9,755	12,035	14,136	16,331	6,871	0	22,368	$3,720
2033	1,391	3,096	5,455	7,672	9,804	12,095	14,207	16,412	6,905	0	22,479	$3,738
2034	1,398	3,112	5,483	7,710	9,853	12,155	14,277	16,494	6,939	0	22,591	$3,757
2035	1,405	3,127	5,510	7,748	9,902	12,215	14,348	16,576	6,974	0	22,704	$3,775
2036	1,412	3,143	5,537	7,787	9,951	12,276	14,420	16,659	7,008	0	22,817	$3,794
2037	1,419	3,158	5,565	7,826	10,001	12,337	14,492	16,742	7,043	0	22,930	$3,813
2038	1,426	3,174	5,593	7,865	10,050	12,399	14,564	16,825	7,078	0	23,045	$3,832
2039	1,433	3,190	5,620	7,904	10,100	12,461	14,637	16,909	7,114	0	23,160	$3,851
2040	1,440	3,206	5,648	7,943	10,151	12,523	14,709	16,993	7,149	0	23,275	$3,870
2041	1,447	3,222	5,677	7,983	10,201	12,585	14,783	17,078	7,185	0	23,391	$3,890
2042	1,454	3,238	5,705	8,022	10,252	12,648	14,856	17,163	7,221	0	23,507	$3,909
2043	1,462	3,254	5,733	8,062	10,303	12,711	14,930	17,248	7,257	0	23,625	$3,929
2044	1,469	3,270	5,762	8,103	10,355	12,774	15,005	17,334	7,293	0	23,742	$3,948
2045	1,476	3,286	5,791	8,143	10,406	12,838	15,080	17,421	7,329	0	23,861	$3,968
2046	1,483	3,303	5,819	8,184	10,458	12,902	15,155	17,507	7,366	0	23,979	$3,988
2047	1,491	3,319	5,848	8,224	10,510	12,966	15,230	17,595	7,402	0	24,099	$4,007
2048	1,498	3,336	5,878	8,265	10,563	13,031	15,306	17,682	7,439	0	24,219	$4,027
2049	1,506	3,352	5,907	8,306	10,615	13,096	15,382	17,770	7,476	0	24,340	$4,047
2050	1,513	3,369	5,936	8,348	10,668	13,161	15,459	17,859	7,513	0	24,461	$4,068

Combination Units (Continued)

MPg Incr/yr:

Class 7-8 Type 1 Incremental Cost vs Average Annual VMT - Non-Centrally Refueled Enhancement A

Year	(thousands of miles) 0-19.9	20-39.9	40-59.9	60-79.9	80-99.9	100-119.9	120-139.9	140-159.9	**Payback Period (yrs): 2** 160-179.9	180-199.9	200+	Veh-Mile Weighted Avg
1995	0	0	0	0	0	0	0	0	0	0	0	$0
1996	0	0	0	0	0	0	0	0	0	0	0	$0
1997	0	0	0	0	0	0	0	0	0	0	0	$0
1998	0	0	0	0	0	0	0	0	0	0	0	$0
1999	0	0	0	0	0	0	0	0	0	0	0	$0
2000	0	0	0	0	0	0	0	0	0	0	0	$0
2001	0	0	0	0	0	0	0	0	0	0	0	$0
2002	0	0	0	0	0	0	0	0	0	0	0	$0
2003	0	0	0	0	0	0	0	0	0	0	0	$0
2004	0	0	0	0	0	0	0	0	0	0	0	$0
2005	749	1,667	2,937	4,130	5,278	6,511	7,648	8,836	3,717	0	12,102	$2,012
2006	926	2,063	3,634	5,111	6,531	8,057	9,464	10,933	4,600	0	14,975	$2,490
2007	1,113	2,479	4,367	6,141	7,848	9,682	11,373	13,138	5,527	0	17,995	$2,992
2008	1,274	2,837	4,998	7,029	8,983	11,082	13,017	15,037	6,326	0	20,596	$3,425
2009	1,447	3,222	5,676	7,982	10,201	12,584	14,782	17,077	7,184	0	23,389	$3,889
2010	1,624	3,615	6,369	8,956	11,446	14,120	16,586	19,161	8,061	0	26,244	$4,364
2011	1,623	3,614	6,367	8,954	11,443	14,117	16,582	19,156	8,059	0	26,237	$4,363
2012	1,620	3,607	6,355	8,937	11,421	14,090	16,550	19,119	8,044	0	26,187	$4,355
2013	1,621	3,608	6,358	8,941	11,426	14,096	16,557	19,128	8,047	0	26,199	$4,357
2014	1,631	3,630	6,397	8,995	11,495	14,181	16,658	19,244	8,096	0	26,358	$4,383
2015	1,628	3,625	6,387	8,982	11,478	14,160	16,633	19,215	8,084	0	26,318	$4,376
2016	1,820	4,053	7,141	10,041	12,832	15,831	18,595	21,482	9,038	0	29,424	$4,893
2017	2,004	4,461	7,860	11,053	14,125	17,425	20,468	23,646	9,948	0	32,387	$5,386
2018	2,175	4,841	8,531	11,996	15,330	18,912	22,215	25,664	10,797	0	35,151	$5,845
2019	2,343	5,216	9,191	12,924	16,516	20,376	23,934	27,650	11,632	0	37,871	$6,298
2020	2,494	5,553	9,785	13,760	17,585	21,694	25,482	29,438	12,385	0	40,320	$6,705
2021	2,510	5,588	9,846	13,845	17,693	21,828	25,640	29,620	12,461	0	40,570	$6,746
2022	2,531	5,635	9,929	13,963	17,844	22,014	25,858	29,872	12,568	0	40,915	$6,804
2023	2,543	5,661	9,974	14,026	17,924	22,112	25,974	30,006	12,624	0	41,099	$6,834
2024	2,564	5,709	10,059	14,145	18,076	22,300	26,194	30,260	12,731	0	41,447	$6,892
2025	2,590	5,766	10,160	14,288	18,259	22,525	26,459	30,566	12,860	0	41,866	$6,962
2026	2,615	5,822	10,258	14,425	18,434	22,741	26,712	30,860	12,983	0	42,267	$7,029
2027	2,615	5,821	10,257	14,423	18,432	22,739	26,710	30,857	12,982	0	42,263	$7,028
2028	2,613	5,818	10,252	14,416	18,423	22,728	26,697	30,842	12,975	0	42,243	$7,025
2029	2,638	5,873	10,348	14,551	18,596	22,941	26,947	31,130	13,097	0	42,638	$7,090
2030	2,651	5,902	10,399	14,624	18,688	23,055	27,081	31,285	13,162	0	42,850	$7,126
2031	2,664	5,931	10,451	14,697	18,781	23,170	27,216	31,441	13,228	0	43,064	$7,161
2032	2,677	5,961	10,503	14,770	18,875	23,285	27,352	31,598	13,294	0	43,278	$7,197
2033	2,691	5,991	10,555	14,843	18,969	23,401	27,488	31,755	13,360	0	43,494	$7,233
2034	2,704	6,020	10,608	14,917	19,063	23,518	27,625	31,913	13,426	0	43,711	$7,269
2035	2,718	6,050	10,661	14,992	19,158	23,635	27,762	32,072	13,493	0	43,929	$7,305
2036	2,731	6,081	10,714	15,066	19,254	23,753	27,901	32,232	13,560	0	44,147	$7,341
2037	2,745	6,111	10,767	15,141	19,350	23,871	28,040	32,393	13,628	0	44,367	$7,378
2038	2,758	6,141	10,821	15,217	19,446	23,990	28,179	32,554	13,696	0	44,588	$7,415
2039	2,772	6,172	10,875	15,293	19,543	24,110	28,320	32,716	13,764	0	44,811	$7,452
2040	2,786	6,203	10,929	15,369	19,640	24,230	28,461	32,879	13,833	0	45,034	$7,489
2041	2,800	6,234	10,984	15,445	19,738	24,351	28,603	33,043	13,902	0	45,258	$7,526
2042	2,814	6,265	11,038	15,522	19,837	24,472	28,745	33,208	13,971	0	45,484	$7,564
2043	2,828	6,296	11,093	15,600	19,935	24,594	28,888	33,373	14,040	0	45,710	$7,601
2044	2,842	6,327	11,149	15,677	20,035	24,716	29,032	33,540	14,110	0	45,938	$7,639
2045	2,856	6,359	11,204	15,756	20,135	24,839	29,177	33,707	14,181	0	46,167	$7,677
2046	2,870	6,390	11,260	15,834	20,235	24,963	29,322	33,875	14,251	0	46,397	$7,715
2047	2,885	6,422	11,316	15,913	20,336	25,088	29,468	34,043	14,322	0	46,628	$7,754
2048	2,899	6,454	11,372	15,992	20,437	25,213	29,615	34,213	14,394	0	46,860	$7,792
2049	2,913	6,486	11,429	16,072	20,539	25,338	29,763	34,383	14,465	0	47,094	$7,831
2050	2,928	6,519	11,486	16,152	20,641	25,464	29,911	34,555	14,538	0	47,329	$7,870

Combination Units (Continued)

MPg Incr/yr:

Class 7-8 Type 1 Incremental Cost vs Average Annual VMT - Non-Centrally Refueled Enhancement A

	(thousands of miles)								**Payback Period (yrs): 3**			Veh-Mile
Year	0-19.9	20-39.9	40-59.9	60-79.9	80-99.9	100-119.9	120-139.9	140-159.9	160-179.9	180-199.9	200+	Weighted Avg
1995	0	0	0	0	0	0	0	0	0	0	0	$0
1996	0	0	0	0	0	0	0	0	0	0	0	$0
1997	0	0	0	0	0	0	0	0	0	0	0	$0
1998	0	0	0	0	0	0	0	0	0	0	0	$0
1999	0	0	0	0	0	0	0	0	0	0	0	$0
2000	0	0	0	0	0	0	0	0	0	0	0	$0
2001	0	0	0	0	0	0	0	0	0	0	0	$0
2002	0	0	0	0	0	0	0	0	0	0	0	$0
2003	0	0	0	0	0	0	0	0	0	0	0	$0
2004	0	0	0	0	0	0	0	0	0	0	0	$0
2005	1,059	2,358	4,156	5,844	7,468	9,213	10,822	12,502	5,260	0	17,123	$2,847
2006	1,326	2,952	5,202	7,315	9,349	11,533	13,547	15,650	6,584	0	21,436	$3,565
2007	1,593	3,547	6,250	8,789	11,232	13,856	16,276	18,803	7,911	0	25,754	$4,283
2008	1,848	4,114	7,249	10,194	13,028	16,072	18,878	21,809	9,175	0	29,871	$4,967
2009	2,097	4,668	8,225	11,567	14,782	18,236	21,420	24,746	10,411	0	33,894	$5,636
2010	2,354	5,241	9,234	12,985	16,594	20,471	24,046	27,779	11,687	0	38,048	$6,327
2011	2,345	5,221	9,200	12,937	16,532	20,396	23,957	27,677	11,644	0	37,908	$6,304
2012	2,352	5,236	9,225	12,973	16,578	20,452	24,024	27,753	11,676	0	38,013	$6,321
2013	2,351	5,235	9,223	12,970	16,575	20,448	24,019	27,748	11,674	0	38,005	$6,320
2014	2,360	5,254	9,258	13,019	16,637	20,525	24,109	27,852	11,717	0	38,148	$6,344
2015	2,366	5,267	9,280	13,050	16,677	20,574	24,166	27,918	11,745	0	38,238	$6,359
2016	2,640	5,878	10,356	14,563	18,611	22,960	26,969	31,156	13,108	0	42,673	$7,096
2017	2,909	6,476	11,411	16,047	20,507	25,298	29,716	34,330	14,443	0	47,020	$7,819
2018	3,157	7,028	12,384	17,415	22,255	27,455	32,250	37,256	15,674	0	51,029	$8,486
2019	3,396	7,560	13,321	18,732	23,938	29,532	34,689	40,075	16,860	0	54,889	$9,128
2020	3,627	8,074	14,226	20,006	25,566	31,540	37,048	42,799	18,006	0	58,621	$9,748
2021	3,647	8,120	14,308	20,120	25,713	31,721	37,260	43,045	18,109	0	58,957	$9,804
2022	3,674	8,179	14,411	20,265	25,897	31,948	37,527	43,353	18,239	0	59,380	$9,874
2023	3,700	8,237	14,514	20,410	26,082	32,177	37,796	43,663	18,370	0	59,804	$9,945
2024	3,729	8,303	14,630	20,573	26,291	32,435	38,098	44,013	18,517	0	60,283	$10,025
2025	3,770	8,393	14,788	20,795	26,575	32,785	38,510	44,489	18,717	0	60,935	$10,133
2026	3,779	8,413	14,824	20,846	26,640	32,865	38,604	44,597	18,762	0	61,083	$10,158
2027	3,794	8,448	14,885	20,931	26,749	32,999	38,761	44,779	18,839	0	61,332	$10,199
2028	3,799	8,458	14,903	20,957	26,781	33,039	38,809	44,833	18,862	0	61,407	$10,211
2029	3,829	8,525	15,022	21,124	26,995	33,303	39,119	45,192	19,013	0	61,897	$10,293
2030	3,848	8,568	15,096	21,229	27,130	33,469	39,313	45,417	19,107	0	62,206	$10,344
2031	3,868	8,611	15,172	21,335	27,265	33,636	39,509	45,643	19,202	0	62,516	$10,396
2032	3,887	8,653	15,247	21,441	27,401	33,803	39,706	45,870	19,298	0	62,827	$10,448
2033	3,906	8,697	15,323	21,548	27,537	33,972	39,904	46,099	19,394	0	63,140	$10,500
2034	3,926	8,740	15,400	21,655	27,674	34,141	40,103	46,329	19,491	0	63,455	$10,552
2035	3,945	8,783	15,476	21,763	27,812	34,311	40,303	46,559	19,588	0	63,771	$10,605
2036	3,965	8,827	15,553	21,872	27,951	34,482	40,503	46,791	19,686	0	64,089	$10,657
2037	3,985	8,871	15,631	21,981	28,090	34,654	40,705	47,025	19,784	0	64,408	$10,711
2038	4,004	8,915	15,709	22,090	28,230	34,826	40,908	47,259	19,882	0	64,729	$10,764
2039	4,024	8,960	15,787	22,200	28,371	35,000	41,112	47,494	19,981	0	65,051	$10,818
2040	4,044	9,004	15,866	22,311	28,512	35,174	41,317	47,731	20,081	0	65,376	$10,871
2041	4,065	9,049	15,945	22,422	28,654	35,350	41,523	47,969	20,181	0	65,701	$10,926
2042	4,085	9,094	16,024	22,534	28,797	35,526	41,729	48,208	20,282	0	66,029	$10,980
2043	4,105	9,140	16,104	22,646	28,940	35,703	41,937	48,448	20,383	0	66,358	$11,035
2044	4,126	9,185	16,184	22,759	29,084	35,881	42,146	48,689	20,484	0	66,688	$11,090
2045	4,146	9,231	16,265	22,872	29,229	36,059	42,356	48,932	20,586	0	67,020	$11,145
2046	4,167	9,277	16,346	22,986	29,375	36,239	42,567	49,176	20,689	0	67,354	$11,200
2047	4,188	9,323	16,427	23,101	29,521	36,420	42,779	49,421	20,792	0	67,690	$11,256
2048	4,209	9,370	16,509	23,216	29,668	36,601	42,992	49,667	20,895	0	68,027	$11,312
2049	4,229	9,416	16,591	23,332	29,816	36,783	43,207	49,914	21,000	0	68,366	$11,369
2050	4,251	9,463	16,674	23,448	29,965	36,967	43,422	50,163	21,104	0	68,707	$11,425

Combination Units (Continued)

MPg Incr/yr:

Class 7-8 Type 1 Incremental Cost vs Average Annual VMT - Non-Centrally Refueled Enhancement A

	(thousands of miles)								Payback Period (yrs): 4			Veh-Mile
Year	0-19.9	20-39.9	40-59.9	60-79.9	80-99.9	100-119.9	120-139.9	140-159.9	160-179.9	180-199.9	200+	Weighted Avg
1995	0	0	0	0	0	0	0	0	0	0	0	$0
1996	0	0	0	0	0	0	0	0	0	0	0	$0
1997	0	0	0	0	0	0	0	0	0	0	0	$0
1998	0	0	0	0	0	0	0	0	0	0	0	$0
1999	0	0	0	0	0	0	0	0	0	0	0	$0
2000	0	0	0	0	0	0	0	0	0	0	0	$0
2001	0	0	0	0	0	0	0	0	0	0	0	$0
2002	0	0	0	0	0	0	0	0	0	0	0	$0
2003	0	0	0	0	0	0	0	0	0	0	0	$0
2004	0	0	0	0	0	0	0	0	0	0	0	$0
2005	1,340	2,983	5,257	7,392	9,446	11,654	13,689	15,814	6,653	0	21,660	$3,602
2006	1,689	3,761	6,626	9,318	11,908	14,691	17,256	19,935	8,387	0	27,305	$4,541
2007	2,047	4,558	8,031	11,294	14,433	17,806	20,915	24,162	10,165	0	33,094	$5,503
2008	2,378	5,294	9,329	13,118	16,764	20,682	24,293	28,065	11,807	0	38,439	$6,392
2009	2,706	6,023	10,613	14,925	19,073	23,530	27,639	31,929	13,433	0	43,733	$7,272
2010	3,025	6,736	11,868	16,690	21,328	26,312	30,907	35,705	15,022	0	48,904	$8,132
2011	3,026	6,736	11,869	16,691	21,330	26,314	30,909	35,708	15,023	0	48,908	$8,133
2012	3,031	6,748	11,890	16,721	21,368	26,361	30,964	35,772	15,049	0	48,995	$8,147
2013	3,030	6,745	11,885	16,713	21,358	26,349	30,950	35,755	15,043	0	48,973	$8,144
2014	3,046	6,782	11,949	16,803	21,473	26,491	31,117	35,948	15,124	0	49,236	$8,188
2015	3,051	6,792	11,968	16,829	21,507	26,532	31,166	36,004	15,147	0	49,314	$8,200
2016	3,409	7,590	13,373	18,805	24,032	29,647	34,825	40,231	16,926	0	55,103	$9,163
2017	3,754	8,357	14,725	20,707	26,462	32,646	38,347	44,300	18,637	0	60,676	$10,090
2018	4,071	9,064	15,971	22,459	28,701	35,408	41,591	48,048	20,214	0	65,810	$10,944
2019	4,387	9,767	17,209	24,200	30,926	38,152	44,815	51,772	21,781	0	70,911	$11,792
2020	4,685	10,430	18,377	25,843	33,026	40,743	47,858	55,287	23,260	0	75,725	$12,592
2021	4,710	10,486	18,477	25,982	33,204	40,963	48,116	55,585	23,385	0	76,134	$12,660
2022	4,750	10,575	18,633	26,203	33,486	41,310	48,524	56,058	23,584	0	76,780	$12,768
2023	4,784	10,651	18,766	26,389	33,724	41,604	48,869	56,456	23,752	0	77,326	$12,859
2024	4,827	10,746	18,935	26,627	34,027	41,979	49,309	56,964	23,965	0	78,022	$12,974
2025	4,853	10,804	19,036	26,769	34,209	42,202	49,572	57,268	24,093	0	78,438	$13,044
2026	4,876	10,856	19,129	26,900	34,376	42,409	49,814	57,548	24,211	0	78,821	$13,107
2027	4,897	10,903	19,211	27,015	34,523	42,591	50,028	57,795	24,315	0	79,159	$13,164
2028	4,907	10,925	19,250	27,071	34,595	42,678	50,131	57,914	24,365	0	79,323	$13,191
2029	4,943	11,005	19,391	27,269	34,848	42,990	50,498	58,337	24,543	0	79,903	$13,287
2030	4,968	11,060	19,488	27,404	35,021	43,205	50,749	58,628	24,665	0	80,301	$13,353
2031	4,993	11,115	19,585	27,541	35,196	43,420	51,002	58,920	24,788	0	80,701	$13,420
2032	5,017	11,171	19,682	27,678	35,371	43,636	51,256	59,213	24,912	0	81,103	$13,487
2033	5,042	11,226	19,781	27,816	35,547	43,854	51,511	59,509	25,036	0	81,507	$13,554
2034	5,068	11,282	19,879	27,955	35,724	44,072	51,768	59,805	25,161	0	81,913	$13,621
2035	5,093	11,338	19,978	28,094	35,902	44,292	52,026	60,103	25,286	0	82,321	$13,689
2036	5,118	11,395	20,078	28,234	36,081	44,512	52,285	60,402	25,412	0	82,731	$13,758
2037	5,144	11,452	20,178	28,375	36,261	44,734	52,546	60,703	25,539	0	83,143	$13,826
2038	5,169	11,509	20,278	28,516	36,442	44,957	52,808	61,006	25,666	0	83,558	$13,895
2039	5,195	11,566	20,379	28,658	36,623	45,181	53,071	61,310	25,794	0	83,974	$13,964
2040	5,221	11,624	20,481	28,801	36,806	45,406	53,335	61,615	25,922	0	84,392	$14,034
2041	5,247	11,682	20,583	28,944	36,989	45,632	53,601	61,922	26,051	0	84,813	$14,104
2042	5,273	11,740	20,685	29,089	37,173	45,860	53,868	62,231	26,181	0	85,235	$14,174
2043	5,299	11,798	20,788	29,233	37,359	46,088	54,136	62,541	26,312	0	85,660	$14,245
2044	5,326	11,857	20,892	29,379	37,545	46,318	54,406	62,852	26,443	0	86,087	$14,316
2045	5,352	11,916	20,996	29,526	37,732	46,549	54,677	63,166	26,574	0	86,516	$14,387
2046	5,379	11,976	21,101	29,673	37,920	46,780	54,949	63,480	26,707	0	86,947	$14,459
2047	5,406	12,035	21,206	29,820	38,109	47,014	55,223	63,797	26,840	0	87,380	$14,531
2048	5,433	12,095	21,312	29,969	38,299	47,248	55,498	64,114	26,974	0	87,815	$14,603
2049	5,460	12,155	21,418	30,118	38,489	47,483	55,775	64,434	27,108	0	88,253	$14,676
2050	5,487	12,216	21,524	30,268	38,681	47,720	56,053	64,755	27,243	0	88,693	$14,749

New MPG

Year	Class 7&8 Type 1				Class 7&8 Type 2				Class 7&8 Type 3				Class 7&8 All				Year	Class 7 & 8 MPG Ratio Type 1	Class 7 & 8 MPG Ratio Type 2	Class 7 & 8--All MPG Ratio	Class 7 & 8 MPG difference
	Conventional	Enhancement A	Enhancement B	New Average	Conventional	Enhancement A	Enhancement B	New Average	Conventional	Enhancement A	Enhancemant B	New Average	Conventional	Enhancement A	Enhancement B	New Average					
2000	6.09	6.09	6.09	6.09	6.69	6.69	6.69	6.69	6.69	6.69	6.69	6.69	6.15	6.15	6.15	6.15	2000	1.00	1.00	1.00	0.00
2001	6.09	6.09	6.09	6.09	6.69	6.69	6.69	6.69	6.69	6.69	6.69	6.69	6.15	6.15	6.15	6.15	2001	1.00	1.00	1.00	0.00
2002	6.09	6.09	6.09	6.09	6.69	6.69	6.69	6.69	6.69	6.69	6.69	6.69	6.15	6.15	6.15	6.15	2002	1.00	1.00	1.00	0.00
2003	6.09	6.09	6.09	6.09	6.69	6.69	6.69	6.69	6.69	6.69	6.69	6.69	6.15	6.15	6.15	6.15	2003	1.00	1.00	1.00	0.00
2004	6.09	6.09	6.09	6.09	6.69	6.69	6.69	6.69	6.69	7.36	6.69	6.69	6.15	6.15	6.15	6.15	2004	1.00	1.00	1.00	0.00
2005	6.09	6.70	6.09	6.09	6.69	7.36	6.69	6.69	6.69	6.69	6.69	6.69	6.15	6.76	6.15	6.15	2005	1.00	1.00	1.00	0.00
2006	6.09	6.93	6.09	6.09	6.69	7.61	6.69	6.69	6.69	6.69	6.69	6.69	6.15	6.99	6.15	6.15	2006	1.00	1.00	1.00	0.00
2007	6.09	7.16	6.09	6.09	6.69	7.85	6.69	6.69	6.69	6.69	6.69	6.69	6.15	7.23	6.15	6.15	2007	1.00	1.00	1.00	0.00
2008	6.09	7.39	6.09	6.09	6.69	8.10	6.69	6.69	6.69	6.69	6.69	6.69	6.15	7.46	6.15	6.15	2008	1.00	1.00	1.00	0.00
2009	6.09	7.62	6.09	6.09	6.69	8.35	6.69	6.69	6.69	6.69	6.69	6.69	6.15	7.69	6.15	6.15	2009	1.00	1.00	1.00	0.00
2010	6.09	7.85	6.09	6.09	6.69	8.59	6.69	6.69	6.69	6.69	6.69	6.69	6.15	7.92	6.15	6.15	2010	1.00	1.00	1.00	0.00
2011	6.09	7.85	6.09	6.09	6.69	8.59	6.69	6.69	6.69	6.69	6.69	6.69	6.15	7.92	6.15	6.15	2011	1.00	1.00	1.00	0.00
2012	6.09	7.85	6.09	6.09	6.69	8.59	6.69	6.70	6.69	6.69	6.69	6.69	6.15	7.92	6.15	6.15	2012	1.00	1.00	1.00	0.00
2013	6.09	7.85	6.09	6.09	6.69	8.59	6.69	6.70	6.69	6.69	6.69	6.69	6.15	7.92	6.15	6.15	2013	1.00	1.00	1.00	0.00
2014	6.09	7.85	6.09	6.10	6.69	8.59	6.69	6.70	6.69	6.69	6.69	6.69	6.15	7.92	6.15	6.16	2014	1.00	1.00	1.00	0.01
2015	6.09	7.85	6.09	6.11	6.69	8.59	6.69	6.72	6.69	6.69	6.69	6.69	6.15	7.92	6.15	6.17	2015	1.00	1.00	1.00	0.02
2016	6.09	8.16	6.09	6.16	6.69	8.88	6.69	6.73	6.69	6.69	6.69	6.69	6.15	8.23	6.15	6.21	2016	1.01	1.01	1.01	0.06
2017	6.09	8.48	6.09	6.25	6.69	9.16	6.69	6.81	6.69	6.69	6.69	6.69	6.15	8.54	6.15	6.30	2017	1.03	1.02	1.03	0.16
2018	6.09	8.79	6.09	6.37	6.69	9.45	6.69	6.84	6.69	6.69	6.69	6.69	6.15	8.85	6.15	6.41	2018	1.05	1.02	1.04	0.27
2019	6.09	9.10	6.09	6.66	6.69	9.74	6.69	6.89	6.69	6.69	6.69	6.69	6.15	9.16	6.15	6.68	2019	1.09	1.03	1.09	0.54
2020	6.09	9.41	6.09	7.28	6.69	10.02	6.69	6.96	6.69	6.69	6.69	6.69	6.15	9.47	6.15	7.24	2020	1.19	1.04	1.18	1.10
2021	6.09	9.41	6.09	7.30	6.69	10.02	6.69	6.98	6.69	6.69	6.69	6.69	6.15	9.47	6.15	7.27	2021	1.20	1.04	1.18	1.12
2022	6.09	9.41	6.09	7.58	6.69	10.02	6.69	6.99	6.69	6.69	6.69	6.69	6.15	9.47	6.15	7.52	2022	1.24	1.05	1.22	1.37
2023	6.09	9.41	6.09	7.69	6.69	10.02	6.69	7.07	6.69	6.69	6.69	6.69	6.15	9.47	6.15	7.62	2023	1.26	1.06	1.24	1.48
2024	6.09	9.41	6.09	7.78	6.69	10.02	6.69	7.12	6.69	6.69	6.69	6.69	6.15	9.47	6.15	7.71	2024	1.28	1.06	1.25	1.56
2025	6.09	9.41	6.09	8.02	6.69	10.02	6.69	7.22	6.69	6.69	6.69	6.69	6.15	9.47	6.15	7.93	2025	1.32	1.08	1.29	1.78
2026	6.09	9.41	6.09	8.02	6.69	10.02	6.69	7.24	6.69	6.69	6.69	6.69	6.15	9.47	6.15	7.93	2026	1.32	1.08	1.29	1.78
2027	6.09	9.41	6.09	8.02	6.69	10.02	6.69	7.24	6.69	6.69	6.69	6.69	6.15	9.47	6.15	7.93	2027	1.32	1.08	1.29	1.79
2028	6.09	9.41	6.09	8.02	6.69	10.02	6.69	7.24	6.69	6.69	6.69	6.69	6.15	9.47	6.15	7.93	2028	1.32	1.08	1.29	1.78
2029	6.09	9.41	6.09	8.02	6.69	10.02	6.69	7.24	6.69	6.69	6.69	6.69	6.15	9.47	6.15	7.94	2029	1.32	1.08	1.29	1.79
2030	6.09	9.41	6.09	8.03	6.69	10.02	6.69	7.24	6.69	6.69	6.69	6.69	6.15	9.47	6.15	7.94	2030	1.32	1.08	1.29	1.79
2031	6.09	9.41	6.09	8.03	6.69	10.02	6.69	7.24	6.69	6.69	6.69	6.69	6.15	9.47	6.15	7.94	2031	1.32	1.08	1.29	1.79
2032	6.09	9.41	6.09	8.03	6.69	10.02	6.69	7.24	6.69	6.69	6.69	6.69	6.15	9.47	6.15	7.94	2032	1.32	1.08	1.29	1.80
2033	6.09	9.41	6.09	8.04	6.69	10.02	6.69	7.24	6.69	6.69	6.69	6.69	6.15	9.47	6.15	7.95	2033	1.32	1.08	1.29	1.80
2034	6.09	9.41	6.09	8.04	6.69	10.02	6.69	7.24	6.69	6.69	6.69	6.69	6.15	9.47	6.15	7.95	2034	1.32	1.08	1.29	1.81
2035	6.09	9.41	6.09	8.05	6.69	10.02	6.69	7.24	6.69	6.69	6.69	6.69	6.15	9.47	6.15	7.96	2035	1.32	1.08	1.29	1.81
2036	6.09	9.41	6.09	8.06	6.69	10.02	6.69	7.25	6.69	6.69	6.69	6.69	6.15	9.47	6.15	7.97	2036	1.32	1.08	1.30	1.82
2037	6.09	9.41	6.09	8.08	6.69	10.02	6.69	7.25	6.69	6.69	6.69	6.69	6.15	9.47	6.15	7.98	2037	1.33	1.08	1.30	1.84
2038	6.09	9.41	6.09	8.08	6.69	10.02	6.69	7.25	6.69	6.69	6.69	6.69	6.15	9.47	6.15	7.99	2038	1.33	1.08	1.30	1.84
2039	6.09	9.41	6.09	8.10	6.69	10.02	6.69	7.25	6.69	6.69	6.69	6.69	6.15	9.47	6.15	8.00	2039	1.33	1.08	1.30	1.85
2040	6.09	9.41	6.09	8.09	6.69	10.02	6.69	7.25	6.69	6.69	6.69	6.69	6.15	9.47	6.15	8.00	2040	1.33	1.08	1.30	1.85
2041	6.09	9.41	6.09	8.10	6.69	10.02	6.69	7.25	6.69	6.69	6.69	6.69	6.15	9.47	6.15	8.00	2041	1.33	1.08	1.30	1.85
2042	6.09	9.41	6.09	8.10	6.69	10.02	6.69	7.26	6.69	6.69	6.69	6.69	6.15	9.47	6.15	8.00	2042	1.33	1.08	1.30	1.86
2043	6.09	9.41	6.09	8.10	6.69	10.02	6.69	7.26	6.69	6.69	6.69	6.69	6.15	9.47	6.15	8.01	2043	1.33	1.08	1.30	1.86
2044	6.09	9.41	6.09	8.10	6.69	10.02	6.69	7.26	6.69	6.69	6.69	6.69	6.15	9.47	6.15	8.01	2044	1.33	1.08	1.30	1.86
2045	6.09	9.41	6.09	8.11	6.69	10.02	6.69	7.26	6.69	6.69	6.69	6.69	6.15	9.47	6.15	8.01	2045	1.33	1.09	1.30	1.86
2046	6.09	9.41	6.09	8.11	6.69	10.02	6.69	7.26	6.69	6.69	6.69	6.69	6.15	9.47	6.15	8.01	2046	1.33	1.09	1.30	1.87
2047	6.09	9.41	6.09	8.11	6.69	10.02	6.69	7.26	6.69	6.69	6.69	6.69	6.15	9.47	6.15	8.02	2047	1.33	1.09	1.30	1.87
2048	6.09	9.41	6.09	8.12	6.69	10.02	6.69	7.26	6.69	6.69	6.69	6.69	6.15	9.47	6.15	8.02	2048	1.33	1.09	1.31	1.88
2049	6.09	9.41	6.09	8.12	6.69	10.02	6.69	7.27	6.69	6.69	6.69	6.69	6.15	9.47	6.15	8.03	2049	1.33	1.09	1.31	1.88
2050	6.09	9.41	6.09	8.13	6.69	10.02	6.69	7.27	6.69	6.69	6.69	6.69	6.15	9.47	6.15	8.03	2050	1.33	1.09	1.31	1.89

Market Vehicle Penetration

Market Penetration of Enhanced Technologies, % of Vehicles Sold

	Diesel Fuel Class 7-8 Type 1		Diesel Fuel Class 7-8 Type 2		Diesel Fuel Class 7-8 Type 3		Diesel Fuel CLASS 7-8 Final	
Year	Type 1 Non-Hybrid	Type 1 Hybrid	Type 2 Non-Hybrid		Type 3 Non-Hybrid		Non-Hybrid	Hybrid
2000	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2001	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2002	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2003	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2004	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2005	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2006	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2007	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2008	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2009	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2010	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2011	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2012	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%
2013	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%
2014	0.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%	0.0%
2015	1.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.8%	0.0%
2016	3.1%	0.0%	0.1%	0.0%	0.0%	0.0%	2.3%	0.0%
2017	6.8%	0.0%	0.2%	0.0%	0.0%	0.0%	5.0%	0.0%
2018	11.1%	0.0%	0.4%	0.0%	0.0%	0.0%	8.1%	0.0%
2019	19.7%	0.0%	0.9%	0.0%	0.0%	0.0%	14.5%	0.0%
2020	36.6%	0.0%	1.5%	0.0%	0.0%	0.0%	26.9%	0.0%
2021	37.3%	0.0%	1.9%	0.0%	0.0%	0.0%	27.5%	0.0%
2022	45.3%	0.0%	2.0%	0.0%	0.0%	0.0%	33.3%	0.0%
2023	48.9%	0.0%	2.8%	0.0%	0.0%	0.0%	36.1%	0.0%
2024	51.7%	0.0%	3.6%	0.0%	0.0%	0.0%	38.4%	0.0%
2025	58.8%	0.0%	5.3%	0.0%	0.0%	0.0%	44.0%	0.0%
2026	58.9%	0.0%	5.5%	0.0%	0.0%	0.0%	44.1%	0.0%
2027	59.0%	0.0%	5.5%	0.0%	0.0%	0.0%	44.2%	0.0%
2028	58.9%	0.0%	5.5%	0.0%	0.0%	0.0%	44.1%	0.0%
2029	59.0%	0.0%	5.6%	0.0%	0.0%	0.0%	44.2%	0.0%
2030	59.1%	0.0%	5.6%	0.0%	0.0%	0.0%	44.2%	0.0%
2031	59.1%	0.0%	5.6%	0.0%	0.0%	0.0%	44.3%	0.0%
2032	59.2%	0.0%	5.6%	0.0%	0.0%	0.0%	44.4%	0.0%
2033	59.3%	0.0%	5.6%	0.0%	0.0%	0.0%	44.4%	0.0%
2034	59.4%	0.0%	5.6%	0.0%	0.0%	0.0%	44.5%	0.0%
2035	59.6%	0.0%	5.6%	0.0%	0.0%	0.0%	44.6%	0.0%
2036	59.8%	0.0%	5.7%	0.0%	0.0%	0.0%	44.8%	0.0%
2037	60.1%	0.0%	5.7%	0.0%	0.0%	0.0%	45.0%	0.0%
2038	60.2%	0.0%	5.7%	0.0%	0.0%	0.0%	45.1%	0.0%
2039	60.5%	0.0%	5.7%	0.0%	0.0%	0.0%	45.3%	0.0%
2040	60.4%	0.0%	5.7%	0.0%	0.0%	0.0%	45.3%	0.0%
2041	60.5%	0.0%	5.8%	0.0%	0.0%	0.0%	45.4%	0.0%
2042	60.6%	0.0%	5.8%	0.0%	0.0%	0.0%	45.4%	0.0%
2043	60.7%	0.0%	5.9%	0.0%	0.0%	0.0%	45.5%	0.0%
2044	60.8%	0.0%	5.9%	0.0%	0.0%	0.0%	45.6%	0.0%
2045	60.9%	0.0%	5.9%	0.0%	0.0%	0.0%	45.6%	0.0%
2046	61.0%	0.0%	5.9%	0.0%	0.0%	0.0%	45.7%	0.0%
2047	61.1%	0.0%	6.0%	0.0%	0.0%	0.0%	45.8%	0.0%
2048	61.3%	0.0%	6.0%	0.0%	0.0%	0.0%	46.0%	0.0%
2049	61.4%	0.0%	6.0%	0.0%	0.0%	0.0%	46.1%	0.0%
2050	61.6%	0.0%	6.1%	0.0%	0.0%	0.0%	46.2%	0.0%

Market Vehicle-Miles Penetration

Market Penetration of Enhancements A and B (In Fraction of Vehicle-Miles)

	Diesel Fuel Class 7-8 Type 1		Diesel Fuel Class 7-8 Type 2		Diesel Fuel Class 7-8 Type 3		Diesel Fuel CLASS 7-8 Final	
Year	Enhancement A	Enhancement B	Enhancement A	Enhancement B	Enhancement A	Enhancement B	Enhancement A	Enhancement B
2000	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	#REF!	#REF!
2001	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2002	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2003	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2004	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2005	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2006	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2007	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2008	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2009	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2010	0.1%	0.0%	0.1%	0.0%	0.0%	0.0%	0.1%	0.0%
2011	0.1%	0.0%	0.1%	0.0%	0.0%	0.0%	0.1%	0.0%
2012	0.2%	0.0%	0.5%	0.0%	0.0%	0.0%	0.2%	0.0%
2013	0.3%	0.0%	0.6%	0.0%	0.0%	0.0%	0.3%	0.0%
2014	0.7%	0.0%	0.7%	0.0%	0.0%	0.0%	0.7%	0.0%
2015	1.6%	0.0%	1.8%	0.0%	0.0%	0.0%	1.6%	0.0%
2016	4.3%	0.0%	2.1%	0.0%	0.0%	0.0%	4.1%	0.0%
2017	9.1%	0.0%	6.7%	0.0%	0.0%	0.0%	8.9%	0.0%
2018	14.3%	0.0%	7.3%	0.0%	0.0%	0.0%	13.6%	0.0%
2019	25.8%	0.0%	9.4%	0.0%	0.0%	0.0%	24.2%	0.0%
2020	46.2%	0.0%	11.5%	0.0%	0.0%	0.0%	42.6%	0.0%
2021	47.0%	0.0%	12.6%	0.0%	0.0%	0.0%	43.5%	0.0%
2022	55.7%	0.0%	13.1%	0.0%	0.0%	0.0%	51.3%	0.0%
2023	58.9%	0.0%	16.3%	0.0%	0.0%	0.0%	54.6%	0.0%
2024	61.6%	0.0%	18.2%	0.0%	0.0%	0.0%	57.1%	0.0%
2025	68.0%	0.0%	22.0%	0.0%	0.0%	0.0%	63.3%	0.0%
2026	68.1%	0.0%	22.7%	0.0%	0.0%	0.0%	63.5%	0.0%
2027	68.2%	0.0%	22.8%	0.0%	0.0%	0.0%	63.6%	0.0%
2028	68.1%	0.0%	22.7%	0.0%	0.0%	0.0%	63.5%	0.0%
2029	68.2%	0.0%	22.8%	0.0%	0.0%	0.0%	63.6%	0.0%
2030	68.3%	0.0%	22.8%	0.0%	0.0%	0.0%	63.7%	0.0%
2031	68.4%	0.0%	22.8%	0.0%	0.0%	0.0%	63.7%	0.0%
2032	68.5%	0.0%	22.9%	0.0%	0.0%	0.0%	63.8%	0.0%
2033	68.6%	0.0%	22.9%	0.0%	0.0%	0.0%	63.9%	0.0%
2034	68.8%	0.0%	23.0%	0.0%	0.0%	0.0%	64.1%	0.0%
2035	68.9%	0.0%	23.0%	0.0%	0.0%	0.0%	64.2%	0.0%
2036	69.2%	0.0%	23.1%	0.0%	0.0%	0.0%	64.5%	0.0%
2037	69.6%	0.0%	23.2%	0.0%	0.0%	0.0%	64.9%	0.0%
2038	69.8%	0.0%	23.2%	0.0%	0.0%	0.0%	65.0%	0.0%
2039	70.2%	0.0%	23.2%	0.0%	0.0%	0.0%	65.4%	0.0%
2040	70.1%	0.0%	23.3%	0.0%	0.0%	0.0%	65.3%	0.0%
2041	70.1%	0.0%	23.4%	0.0%	0.0%	0.0%	65.4%	0.0%
2042	70.2%	0.0%	23.5%	0.0%	0.0%	0.0%	65.4%	0.0%
2043	70.3%	0.0%	23.5%	0.0%	0.0%	0.0%	65.5%	0.0%
2044	70.4%	0.0%	23.6%	0.0%	0.0%	0.0%	65.6%	0.0%
2045	70.4%	0.0%	23.6%	0.0%	0.0%	0.0%	65.7%	0.0%
2046	70.5%	0.0%	23.7%	0.0%	0.0%	0.0%	65.7%	0.0%
2047	70.6%	0.0%	23.7%	0.0%	0.0%	0.0%	65.8%	0.0%
2048	70.8%	0.0%	23.8%	0.0%	0.0%	0.0%	66.0%	0.0%
2049	70.9%	0.0%	23.9%	0.0%	0.0%	0.0%	66.1%	0.0%
2050	71.1%	0.0%	23.9%	0.0%	0.0%	0.0%	66.2%	0.0%

Detailed Inputs Market Vehicle-Miles Penetration

Run Macro

1. Select Enhancement B Fuel Type

Diesel Fuel

2. Enter Discount Rate

7.5%

3. Enter Baseline Fuel Efficiency Escalation Factor

1.000

4. Run Macro

TYPE 1: Multi-stop or Step Van; Beverage; Utility; Winch or Crane; Wrecker; Pole, Logging, Pipe; Service; Garbage; Dump; Cement Mixer; Yard Tractor and Other

Macro last run on: 11/16/2004 15:59 Macro last run on: 11/16/2004 15:59

TYPE 2: Platform with devices; Low-boy platform; Basic platform; Livestock; Automobile Transport; Oilfield; Grain; Tank truck for liquids or gases; Tank truck for dry bulk

Macro last run on: 11/16/2004 15:58 Macro last run on: 11/16/2004 15:58

TYPE 3: Insulated; Non-refrigerated; Insulated Refrigerated; Drop Frame, Open Top, Basic Enclosed Pipe; Service; Garbage; Dump; Cement Mixer; Yard Tractor and Other

Macro last run on: 3/24/2005 10:06 Macro last run on: 3/24/2005 10:06

TYPE MEDIUM (Classes 3-6):

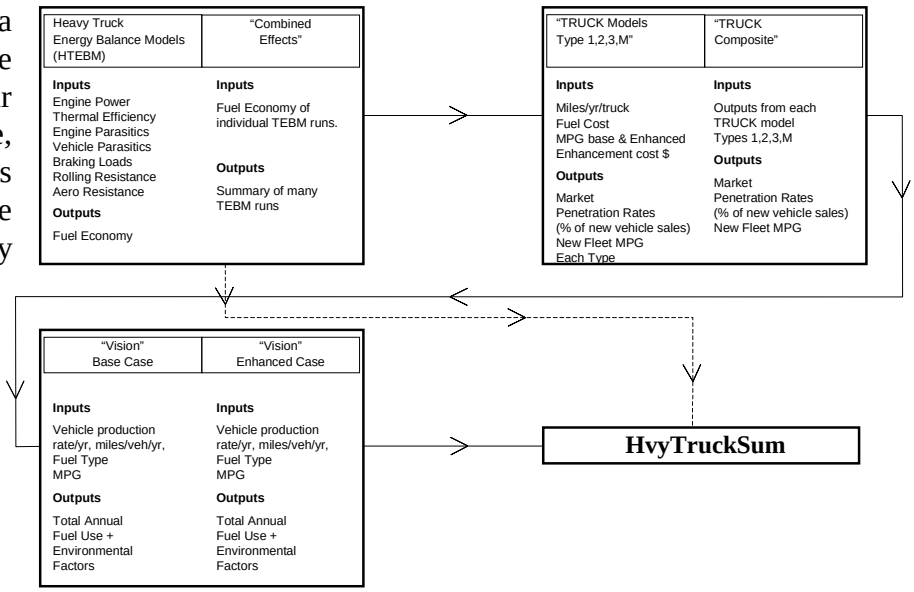
Macro last run on: 12/28/2004 12:43 Macro last run on: 12/28/2004 12:43

Appendix B

B.1 Heavy Truck Energy Use Models: Workbooks, Inputs and Outputs

Specific workbooks used in the modeling system are listed below. Exhibit B-1 provides a detailed view of the relationships among the four principal models. In practice, calendar dates indicating times of use are added to the file names for specific Energy Benefits analysis exercises, but these are omitted in this discussion.

Exhibit B-1: Heavy Truck Energy Modeling System Details



1. Heavy Truck Energy Balance Model (HTEBM)-Version 2.0
    - Energy Balance Workbook-Baseline Model
    - Energy Balance Workbook-Technology Model(s) (copied from the Baseline Model) (mention surrogates for cycles.)
    - Combined –Effects (used to allocate fuel savings among several technologies).
2. TRUCK (Market Penetration) Models
    - TRUCK-2 Type 1 (projects market penetration of Class 7&8, Type 1 heavy trucks to 2050).
    - TRUCK-2 Type 2 (projects market penetration of Class 7&8, Type 2 heavy trucks to 2050).
    - TRUCK-2 Type M (projects market penetration of Classes 3-6 Type heavy trucks to 2050).
    - TRUCK-2 Composite (combines all Type 1, 2, 3, M results to obtain summary market penetrations and fleet average fuel economies).
3. VISION MODELS
    - VISION 2005 AEO ICE MPG Base Case (projects energy use of baseline truck fleet to 2050).
    - VISION GPRA0 7Veh.Mi-1 (projects energy use of improved truck fleet to 2050).
4. HvyTrkSum-GPRA-V1 mkt pen veh mi (calculates energy and carbon savings-total heavy truck fleet, classes 3-8, to 2050).

All workbooks should be copied into the same hard drive subdirectory and all should be loaded so that all of the links are active during the data entry and calculation process.

B.1.1 HTEBM (Heavy Truck Energy Balance Model) Version 2.0

The Heavy Truck Energy Balance Model is based on a simplified calculation of average road loads experienced by typical heavy trucks. The model is a method to match baseline vehicles with actual road-load fuel economy results and then to estimate the variations in fuel economy that will occur when various engine and vehicle operational characteristics are changed. Therefore, it is important that actual, simulation-based, or program goals for road-load vehicle fuel economy values be available.

Fuel savings are caused by a combination of technologies-load reducing technologies and engine efficiency-increasing technologies. Each technology under consideration and each analysis year requires a separate run of HTEBM. Since each run includes both input assumptions and results, they need to be maintained for adequate support and documentation.

Engine/Vehicle improvements that lead to reduced fuel use can be categorized under the following headings.

- Increased engine cycle efficiency
    - Increase compression ratio
    - Reduced engine thermal losses
- Reduced engine internal friction loads
    - Air-Breathing Losses
    - Pistons & Piston Rings
    - Rod and crankshaft bearings
    - Valve train/camshaft
- Reduced engine accessory loads
    - Fuel Injector
    - Power Steering
    - Oil Pump
    - Coolant Pump
    - Engine fan
- Reduced drive-train parasitic loads
    - Transmission
    - Driveshaft
    - Axle/Transaxle
    - Differential
    - Axle & Wheel bearings
    - Brake Drag

- Reduced vehicle auxiliary system loads
    - Alternator
    - Air Conditioner
    - Air Brake Compressor
- Reduced road-loads
    - Aerodynamic loads
    - Rolling resistance loads
    - Braking loads.

For the Government Performance and Review Analysis (GPRA), vehicle characteristics to support fuel economy goals at 10-year increments are developed (2010, 2020, 2030, 2040, and 2050).

- **"Combined Effects" Workbook**

The results of the multiple runs of HTEBM are collected in this summary workbook. This is shown as Exhibit B-2. Whereas HTEBM permits only one set of conditions per-run, "Combined Effects" can store any number of HTEBM results.

The Combined Effects Submodel is used to allocate the fuel savings among the several technologies included in the Truck Technology option. This is done by assuming that the percentage of fuel savings attributable to each separate technology will be proportional to the relative fuel economy improvement of each separate technology, taken separately.

Currently, "Combined Effects" includes four individual heavy vehicle technologies (accessory loads reduction, engine efficiency increase, vehicle weight reduction, and aerodynamic drag reduction). These can be varied to other technologies or Technology Program definitions by the user, if desired.

B.1.2 TRUCK 2.0 Market Penetration Models

The fuel-saving technologies under analysis are characterized in TRUCK models for types 1,2, and 3 in terms of the projected fuel economy improvement ratio (new fuel economy divided by the baseline fuel economy), the installed cost of the improvement ($ per vehicle), and the cost of the fuel type being used. Market penetration occurs for technologies that meet payback values of 4 years or less. TRUCK 2.0 can be set to assume the following heavy truck fuels: diesel fuel, gasoline, liquefied propane gas (LPG), ethanol, compressed natural gas (CNG), or electricity (battery storage).

The output from the TRUCK 2.0 Models for each truck Type is a projection of market penetration rates (percent of new vehicle sales) by class and type over the future time from current through year 2050 (or shorter if modeled for a shorter time period). The absolute number of trucks projected to be equipped with the new technology is calculated in the VISION model (see below).

Exhibit B-2: Combined Effects Workbook

	Fuel Economy, mpg	Single Technol. Benefit, %	Contribution Based on Single Technol. Benefit., %	Fuel Economy, mpg	Single Technol. Benefit, %	Contribution Based on Single Technol. Benefit., %	Fuel Economy, mpg	Single Technol. Benefit, %	Contribution Based on Single Technol. Benefit., %	Fuel Economy, mpg	Single Technol. Benefit, %	Contribution Based on Single Technol. Benefit., %	Fuel Economy, mpg	Single Technol. Benefit, %	Contribution Based on Single Technol. Benefit., %
	Type 1			Type 2			Type 3			Medium			Medium		
Baseline	6.11	0.0%		6.6660309	0.0%		0.00	0.0%		8.873845	0.0%	0.0%	9.391621227	0.0%	0.0%
Auxiliary Loads Electrification	6.14	0.5%	1.6%	6.83	2.5%	9.2%	0.00	0.0%	0.0%	8.9911859	1.3%	5.6%	9.45503725	0.7%	2.9%
Engine Efficiency, WHR	7.61	24.6%	87.8%	8.19	22.9%	83.7%	0.00	0.0%	0.0%	10.81026	21.8%	92.5%	11.3308673	20.6%	89.7%
Vehicle Weight Reduction	6.11	0.0%	0.0%	6.67	0.0%	0.0%	0.00	0.0%	0.0%	8.873845	0.0%	0.0%	9.391621227	0.0%	0.0%
Aerodynamic Load Reduction	6.29	3.0%	10.6%	6.79	1.9%	7.0%	0.00	0.0%	0.0%	8.9141145	0.5%	1.9%	9.550471534	1.7%	7.3%
Sum of Individual Benefits	--	28.1%	100.0%	--	27.4%	100.0%	--	0.0%	0.0%	--	23.6%	100.0%	--	23.0%	100.0%
Combined Effects	7.88	28.9%		8.56	28.5%		0.00	0.0%		11.00	24.0%	100.00%	11.60032281	23.5%	28.41%
Hybrid	8.5519849	0.4								8.873845	0.0%	0.00%	14.957	59.3%	71.59%
										Medium	24.0%	100.0%	Medium	82.8%	100.0%
Corrected MPGS & Ratios	#REF!	#REF!		#REF!	#REF!		#REF!	#REF!		#REF!	#REF!		Done 5-16-05		

2020

	Fuel Economy, mpg	Single Technol. Benefit, %	Contribution Based on Single Technol. Benefit., %	Fuel Economy, mpg	Single Technol. Benefit, %	Contribution Based on Single Technol. Benefit., %	Fuel Economy, mpg	Single Technol. Benefit, %	Contribution Based on Single Technol. Benefit., %	Fuel Economy, mpg	Single Technol. Benefit, %	Contribution Based on Single Technol. Benefit., %	Fuel Economy, mpg	Single Technol. Benefit, %	Contribution Based on Single Technol. Benefit., %
	Type 1			Type 2			Type 3			Medium			Medium		
Baseline	6.11	0.0%		6.6660309	0.0%		0.00	0.0%	0.0%	8.9	0.0%	0.0%	9.4	0.0%	0.0%
Auxiliary Loads Electrification	6.16	0.9%	1.8%	6.95	4.3%	9.1%	0.00	0.0%	0.0%	9.1	2.7%	6.2%	9.5	1.4%	3.2%
Engine Efficiency, WHR	8.82	44.3%	86.3%	9.39	40.9%	86.8%	0.00	0.0%	0.0%	12.4	39.6%	91.7%	12.9	37.1%	88.5%
Vehicle Weight Reduction	6.11	0.0%	0.0%	6.67	0.0%	0.0%	0.00	0.0%	0.0%	8.9	0.0%	0.0%	9.4	0.0%	0.0%
Aerodynamic Load Reduction	6.48	6.1%	11.9%	6.79	1.9%	4.1%	0.00	0.0%	0.0%	9.0	0.9%	2.1%	9.7	3.4%	8.2%
Sum of Individual Benefits	--	51.4%	100.0%	--	47.1%	100.0%	--	0.0%	0.0%	--	43.2%	100.0%	--	42.0%	100.0%
Combined Effects	9.44	54.6%		9.98	49.8%		0.00	0.0%		12.84	44.7%	100.00%	13.5	43.8%	42.50%
Hybrid	9.773697	0.6								8.873845	0.0%	0.00%	14.957	59.3%	57.50%
										Medium	44.7%	100.0%	Medium	103.1%	100.0%

2030

	Fuel Economy, mpg	Single Technol. Benefit, %	Contribution Based on Single Technol. Benefit., %	Fuel Economy, mpg	Single Technol. Benefit, %	Contribution Based on Single Technol. Benefit., %	Fuel Economy, mpg	Single Technol. Benefit, %	Contribution Based on Single Technol. Benefit., %	Fuel Economy, mpg	Single Technol. Benefit, %	Contribution Based on Single Technol. Benefit., %	Fuel Economy, mpg	Single Technol. Benefit, %	Contribution Based on Single Technol. Benefit., %
	Type 1			Type 2			Type 3			Medium			Medium		
Baseline	6.11	0.0%		6.6660309	0.0%		0.00	0.0%		8.9	0.0%		9.4	0.0%	
Auxiliary Loads Electrification	6.16	0.9%	1.8%	6.95	4.3%	9.1%	0.00	0.0%	0.0%	9.1	2.7%	6.2%	9.5	1.4%	3.2%
Engine Efficiency, WHR	8.82	44.3%	86.3%	9.39	40.9%	86.8%	0.00	0.0%	0.0%	12.4	39.6%	91.7%	12.9	37.1%	88.5%
Vehicle Weight Reduction	6.11	0.0%	0.0%	6.67	0.0%	0.0%	0.00	0.0%	0.0%	8.9	0.0%	0.0%	9.4	0.0%	0.0%
Aerodynamic Load Reduction	6.48	6.1%	11.9%	6.79	1.9%	4.1%	0.00	0.0%	0.0%	9.0	0.9%	2.1%	9.7	3.4%	8.2%
Sum of Individual Benefits	--	51.4%	100.0%	--	47.1%	100.0%	--	0.0%	0.0%	--	43.2%		--	42.0%	
Combined Effects	9.44	54.6%		9.98	49.8%		0.00	0.0%		12.84	44.7%	100.00%	13.5	43.8%	39.71%
Hybrid	9.773697	0.6								8.873845	0.0%	0.00%	15.63791527	66.5%	60.29%
										Medium	44.7%	100.0%	Medium	110.3%	100.0%

2040

	Fuel Economy, mpg	Single Technol. Benefit, %	Contribution Based on Single Technol. Benefit., %	Fuel Economy, mpg	Single Technol. Benefit, %	Contribution Based on Single Technol. Benefit., %	Fuel Economy, mpg	Single Technol. Benefit, %	Contribution Based on Single Technol. Benefit., %	Fuel Economy, mpg	Single Technol. Benefit, %	Contribution Based on Single Technol. Benefit., %	Fuel Economy, mpg	Single Technol. Benefit, %	Contribution Based on Single Technol. Benefit., %
	Type 1			Type 2			Type 3			Medium			Medium		
Baseline	6.11	0.0%		6.6660309	0.0%		0.00	0.0%		8.9	0.0%		9.4	0.0%	
Auxiliary Loads Electrification	6.16	0.9%	1.8%	6.95	4.3%	9.1%	0.00	0.0%	0.0%	9.1	2.7%	6.2%	9.5	1.4%	3.2%
Engine Efficiency, WHR	8.82	44.3%	86.3%	9.39	40.9%	86.8%	0.00	0.0%	0.0%	12.4	39.6%	91.7%	12.9	37.1%	88.5%
Vehicle Weight Reduction	6.11	0.0%	0.0%	6.67	0.0%	0.0%	0.00	0.0%	0.0%	8.9	0.0%	0.0%	9.4	0.0%	0.0%
Aerodynamic Load Reduction	6.48	6.1%	11.9%	6.79	1.9%	4.1%	0.00	0.0%	0.0%	9.0	0.9%	2.1%	9.7	3.4%	8.2%
Sum of Individual Benefits	--	51.4%	100.0%	--	47.1%	100.0%	--	0.0%	0.0%	--	43.2%	100.0%	--	42.0%	100.0%
Combined Effects	9.44	54.6%		9.98	49.8%		0.00	0.0%		12.84	44.7%	100.00%	13.5	43.8%	39.71%
Hybrid	9.773697	0.6								8.873845	0.0%	0.00%	15.63791527	66.5%	60.29%
										Medium	44.7%	100.0%	Medium	110.3%	100.0%

2050

	Fuel Economy, mpg	Single Technol. Benefit, %	Contribution Based on Single Technol. Benefit., %	Fuel Economy, mpg	Single Technol. Benefit, %	Contribution Based on Single Technol. Benefit., %	Fuel Economy, mpg	Single Technol. Benefit, %	Contribution Based on Single Technol. Benefit., %	Fuel Economy, mpg	Single Technol. Benefit, %	Contribution Based on Single Technol. Benefit., %	Fuel Economy, mpg	Single Technol. Benefit, %	Contribution Based on Single Technol. Benefit., %
	Type 1			Type 2			Type 3			Medium			Medium		
Baseline	6.11	0.0%		6.6660309	0.0%		0.00	0.0%		8.9	0.0%		9.4	0.0%	
Auxiliary Loads Electrification	6.16	0.9%	1.8%	6.95	4.3%	9.1%	0.00	0.0%	0.0%	9.1	2.7%	6.2%	9.5	1.4%	3.2%
Engine Efficiency, WHR	8.82	44.3%	86.3%	9.39	40.9%	86.8%	0.00	0.0%	0.0%	12.4	39.6%	91.7%	12.9	37.1%	88.5%
Vehicle Weight Reduction	6.11	0.0%	0.0%	6.67	0.0%	0.0%	0.00	0.0%	0.0%	8.9	0.0%	0.0%	9.4	0.0%	0.0%
Aerodynamic Load Reduction	6.48	6.1%	11.9%	6.79	1.9%	4.1%	0.00	0.0%	0.0%	9.0	0.9%	2.1%	9.7	3.4%	8.2%
Sum of Individual Benefits	--	51.4%	100.0%	--	47.1%	100.0%	--	0.0%	0.0%	--	43.2%	100.0%	--	42.0%	100.0%
Combined Effects	9.44	54.6%		9.98	49.8%		0.00	0.0%		12.84	44.7%	100.00%	13.5	43.8%	39.71%
Hybrid	9.773697	0.6								8.873845	0.0%	0.00%	15.63791527	66.5%	60.29%
										Medium	44.7%	100.0%	Medium	110.3%	100.0%

- **"TRUCK Composite" Submodel**

This model collects the market penetration data from the four TRUCK models. It was created as a separate workbook since the TRUCK models are all driven by macros and with distinct inputs. The market penetration and fuel economy results for each of the truck Types are linked to this workbook.

B.1.3 VISION Models

- **VISION Base Case Model**

The VISION models accept average new fleet MPG values for Class 3-6 and Class 7 & 8 vehicles and calculate the amount of fuel used each year as these vehicles mature, age and eventually wear out within the operating fleet. Calculations are made for the years 2000 to 2050.

- **VISION Enhanced Case Model**

This version of VISION calculates the fleet energy use assuming that the proposed technologies (fuel savings technologies) are introduced into the new vehicle fleet as calculated by the TRUCK models. Fuel economy and market penetration results from the TRUCK models are consolidated into a single value (for each year to 2050) for Class 7 and 8, and a single value for Classes 3 through 6, using VMT data to weight the fuel economies of each truck Type.

B.1.4 Heavy Truck Summary Submodel (HvyVehSum)

Key inputs and results of the Truck Model analysis are summarized in the HvyTrkSum workbook. The format used here is intended to meet the needs and requirements of the FutureCar and Vehicle Technologies program, as well as the Planning and Evaluation Office.

HvyTrkSum results form the basis of the GPRA and related reports generated annually presenting the benefits of the Heavy Truck program elements.

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